TEDDY

1986

TERI ENERGY DATA DIRECTORY AND YEARBOOK

TEDDY

1986

TATA ENERGY RESEARCH INSTITUTE
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PREFACE

The Tata Energy Research Institute (TERI) is a non profit research institution engaged in finding solutions to the country's energy problems. The researchers working in this Institute have over a period of time found that while diverse data related to energy supply and consumption is generally available from different sources in adequate measure, a comprehensive compilation providing all kinds of energy and related data is not currently available. It is in cognizance of this need that TERI's Energy Data Directory and Yearbook (TEDDY) has been compiled and is being published for the benefit of energy researchers, planners and organisations dealing with energy questions. This particular issue being the inaugural issue of an intended continuing series, obviously has gaps and deficiencies which over a period of time will be made good, particularly in response to opinions and suggestions received from users from time to time. Some of the deficiencies that exist in this first volume are known to the authors, but could not be removed, on account of non-availability of data in the form and manner required. Given the developments that are taking place and the generally observed opening up of information available with the Government, it is hoped that the type of data required but not currently available will over a period of time become available for inclusion in TEDDY.

While reiterating our desire to receive suggestions and opinions on how to improve this compilation in subsequent years, we also appeal to the repositories of information to make available data that currently is not available for public dissemination. It is hoped that such organisations would see the benefit of information sharing, by which all those engaged in the process of information collection and compilation would benefit overall. In other words, the mutuality of benefits from sharing information and seeing it compiled in a comprehensive manner, we hope, would get us cooperation and assistance in enriching future publications in this series. Over a period of time a much stronger analytical component is also expected to be built into this publication, so that not only are facts and figures presented for use by all concerned but also adequate analysis and interpretation is provided to review trends in energy consumption and supply in India.

The data and other information in this booklet/publication have been compiled largely by Mr. Kapil Thukral, who received several valuable suggestions and inputs from various TERI professionals, and in particular, Dr. V.V.N. Kishore and Dr. (Mrs.) Veena Joshi. Thanks are also due to Miss T.G. Usha, who did a superlative job of typing and editing the manuscript.

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I. OVERVIEW

Energy is an essential input for all economic activities; and energy production, trade and utilization are closely linked to the rest of the economy. Therefore, it becomes difficult to make rational energy sector investment plans, or to devise appropriate energy pricing policies, without considering the linkages with development trends and policy objectives for other economic sectors, as well as with the external environment.

In order to understand energy-economy linkages, it is necessary to identify the structural determinants of energy consumption, and analyze the impact of energy shortages and energy price movements. Only after such issues have been studied, is it possible to analyze the scope and potential for energy demand management.

It is against this background that it becomes necessary and relevant to review not only the energy supply-side data base, but also certain demand aspects as well. Here, reference is made only to published data; for although considerable data may be compiled by various institutions and/or energy consumers themselves, these data are seldom published, and are (in general) not available to energy planners and researchers. The summary data presented in subsequent chapters reflects largely the data available through published documents; and not what may be required by an energy policy analyst. Certain gaps in published data are also identified.

Data published by the organized energy supply industries (notably coal, petroleum and natural gas, and electricity) are generally better organized than user-related data. Time series data are also available, particularly since 1970/71. However, there is still considerable scope for expanding the coverage of information published for the energy supply industries. On the other hand, published data on supply/demand of traditional fuels, and user-related data are often inadequate. Either only normative data, or that collected through isolated sample surveys, or very aggregate level data are usually available. However, an attempt is made to present the published data meaningfully.

II. ENERGY SUPPLY

II.1. Coal

Coal is the most abundant commercial energy source in India. Indian coals are largely of bituminous grade, and an estimated 99.5% of indigenous coal resources are in the Gondwana Basins. A total of about 159 billion tonnes of resources occur upto a depth of about 1200 metres. Of these, about 70% occur in seams of thickness 0.5 metres or more. About 46 billion tonnes of the estimated reserves are actually proven.

However, with the current mining methods, only a part of the proven reserves can be recovered, and efforts are being made to improve mining techniques by : (i) increasing open cast mining operations, by converting underground mines to open cast mines, and by employing techniques that permit open cast mining at greater depths; (ii) introducing Longwall Method of underground mining in place of the conventional Bord and Pillar Method; and (iii) gradually introducing more heavy-duty machinery that permits mining at greater depths and from thinner seams.

The average quality of Indian coals is rather low. A little over 70% of the proven reserves are of the non-coking variety. Prime coking coals are found only in the Jharia coalfields of Bihar. The share of production of non-coking coals has ranged between 72% to 78% of total coal production since 1975/76. And there is reason to believe that the average calorific content of coals produced has dropped significantly -- albeit gradually -- in recent years. This may be due to an increase in production from mechanized open cast mines, which leads to significant proportions of free dirt, boulders, and other lumpy, extraneous matter along with coal.

However, coal beneficiation still continues to be restricted largely to coking coals, although there are plans to instal suitable washeries that can clean non-coking coals as well. The inability to beneficiate non-coking coals has also imposed a heavy demand on the nation's transportation system. The inability to transport mined coal is readily evident from data on rapidly rising pithead stocks.

Table II.1.1: Non-Coking Coal Reserves (as on April 1, 1986)

State	Depth (metres)	Reserves (MMT) Proved	Indicated	Inferred	Total
a. West Bengal	0-300	5424.71	5904.45	890.38	12219.54
	300-600	583.85	4331.16	2278.51	7193.52
	600-1200	156.36	1490.14	4868.06	6514.56
b. Bihar	0-300	7202.85	12375.07	2613.54	22191.46
	300-600	1698.15	4355.42	2430.27	8483.84
	600-1200	-	1038.00	-	1038.00
c. Madhya Pradesh	0-300	7926.44	9175.50	3202.25	20304.19
	300-600	340.43	682.23	1774.42	2797.08
d. Maharashtra	0-300	2052.60	960.10	600.00	3612.70
	300-600	35.50	107.20	1320.00	1462.70
e. Orissa	0-300	3482.58	9389.30	12089.65	24961.53
	300-600	69.38	1547.57	7855.07	9472.02
	600-1200	1.22	28.24	-	29.46
f. Andhra Pradesh	0-300	3148.26	389.90	-	3538.16
	300-600	482.46	1754.14	30.00	2266.60
	600-1200	1.75	37.75	3617.78	3657.28
g. Others	0-300	83.56	193.41	424.47	701.44
	300-600	1.31	70.69	67.81	139.81
h. All	0-300	29321.00	38387.73	19820.29	87529.02
	300-600	3211.08	12848.41	15756.08	31815.57
	600-1200	159.33	2594.13	8485.84	11239.30
	0-1200	32691.41	53830.27	44062.21	130583.89

a. Includes Raniganj, East Barjora, Darjeeling and Deocha Basin coalfields.
b. Includes Jharia, East Bokaro, West Bokaro, North Karanpura, South Karanpura, Auranga, Hutar, Daltonganj, Deogarh and Rajmahal coalfields.
c. Includes Umaria, Pench-Kanhan, Gurgunda, Sendurgarh, Hasdo-Arand, Singrauli, Bisrampur, Sonhat, Jhilmili, Chirmiri, Sohagpur, Pathakhera, Korba, Johilla, Mand-Raigarh, Lakhanpur, Mokopani and Tatapani-Ramkola coalfields.
d. Includes Chanda-Wardha, Kamptee, Umrer, Bander, Nand, Makardhokra and Bokhara coalfields.
e. Includes Ib-River and Talcher coalfields.
f. Includes coalfields in the Godavari Valley.
g. Includes Makum, Dilli-Jeypore, Namchik, Mikir Hill, West Darenggiri, Dalphakram-Pendenguru, Siju, Languir, Mawlong-Shella, Khasi Hills, Barjan and Nagaland coalfields.

Source : Planning Commission.

Table II.1.2 : Coking and Blendable Coal Reserves
(As on April 1, 1986)

State	Depth (metres)	Reserves (MT) Proved	Indicated	Inferred	Total
A. Prime Coking Coals					
b. Bihar	0-300	2165.64	155.48	1.72	2322.84
	300-600	1368.82	759.26	287.23	2415.31
	600-1200	89.00	643.04	-	732.04
	0-1200	3623.46	1557.78	288.95	5470.19
B. Medium Coking Coal*					
a. West Bengal	0-300	102.22	48.27	0.32	150.81
	300-600	9.79	80.85	14.86	105.50
	600-1200	0.09	3.90	28.01	32.00
b. Bihar	0-300	5876.53	4077.63	354.33	10308.49
	300-600	2388.30	2978.07	339.00	5705.37
	600-1200	707.22	1894.18	-	2601.40
c. Madhya Pradesh	0-300	155.56	232.11	40.00	427.67
	300-600	48.46	220.83	58.21	327.50
d. All	0-300	6134.31	4358.01	394.65	10886.97
	300-600	2446.55	3279.75	412.07	6138.37
	600-1200	707.31	1898.08	28.01	2633.40
	0-1200	9288.17	9535.84	834.73	19658.74
C. Blendable Coals					
a. West Bengal	0-300	338.54	133.02	3.59	475.15
	300-600	100.84	440.63	48.69	590.16
	600-1200	76.31	240.88	555.73	872.92
b. Bihar	0-300	216.51	174.79	23.52	414.82
	300-600	53.50	282.72	52.90	389.12
	600-1200	0.42	4.13	5.06	9.61
c. All	0-300	555.05	307.81	27.11	869.97
	300-600	154.34	723.35	101.59	979.28
	600-1200	76.73	245.01	560.79	882.53
	0-1200	786.12	1276.17	689.49	2751.78

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* Includes semi and weakly-coking coals.

a. Includes Raniganj coalfields.
b. Includes Jharia, East Bokaro, West Bokaro, North Karanpura and South Karanpura coalfields.
c. Includes Pench-Kanhan, Sonhat and Sohagpur coalfields.

Source : Planning Commission.

Table II.1.3 : Production, Despatches and Closing Stock of Coal— All India (million tonnes)

		1975/76	1977/78	1979/80	1981/82	1983/84
a.	Production (total)	99.68	100.97	103.95	124.23	136.24
a.1.	Coking	22.19	23.31	23.50	30.25	35.98
a.2.	Non-Coking	77.49	77.66	80.45	93.98	102.26
b.	Despatches (total)	91.96	99.50	99.58	118.10	130.27
b.1.	Coking	21.16	22.85	21.33	24.54	34.85
b.2.	Non-coking	70.80	76.65	78.25	93.56	95.42
b.3.	From CIL* (total)	77.96	84.72	84.23	103.34	114.66
	- by rail	59.81	63.02	54.83	69.78	NA
	- by road	13.38	16.36	23.33	26.61	NA
	- by other means	4.77	5.34	6.07	6.95	NA
b.4.	From other coal companies**	14.00	14.78	15.35	14.76	15.61
c.	Closing stock at end of year(total)	11.84	12.18	14.01	21.25	22.89
c.1.	Coking	1.67	2.24	3.94	9.07	7.10
c.2.	Non-coking	10.17	9.94	10.07	12.18	15.79

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* Coal India Ltd. (CIL), includes Eastern Coalfields Ltd. (ECL), Bharat Coking Coal Ltd. (BCCL), Central Coalfields Ltd. (CCL), Western Coalfields Ltd. (WCL) and North-Eastern Coalfields Ltd.(NECL).

** Includes Singareni Collieries Company Ltd. (SCCL), Tata Iron and Steel Company Ltd. (TISCO), Indian Iron and Steel Company Ltd. (IISCO), Damodar Valley Corporation (DVC) and coalfields in Jammu and Kashmir.

Source : Coal Controllers' Organization, All India Annual Coal Statistics 1983/84, GOI, Calcutta.

Table II.1.4 : Production of Coal By Grade and Company (1983/84)

Grade	ECL	BCCL	CCL	WCL	NECL	CIL	SCCL	TISCO	IISCO	DVC	J & K	Total
A. Coking Coals												
S-I	-	0.336	-	-	-	0.336	-	-	-	-	-	0.336
S-II	-	2.379	0.359	-	-	2.738	-	0.201	0.019	-	-	2.958
W-I	0.072	1.382	0.183	-	-	1.637	-	0.612	-	-	-	2.249
W-II	0.180	2.488	5.081	0.632	-	8.376	-	0.702	0.150	-	-	9.228
W-III	0.168	5.420	5.609	-	-	11.197	-	0.702	0.157	-	-	12.056
W-IV	-	5.504	1.455	-	-	6.959	-	1.124	0.317	-	-	8.400
S/C-I	0.589	-	-	0.167	-	0.756	-	-	-	-	-	0.756
S/C-II	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total	1.009	17.504	12.687	0.799	-	31.999	-	3.341	0.648	-	-	35.988
B. Non-Coking Coals												
A	1.196	-	1.383	1.811	-	4.390	-	-	-	-	-	4.390
B	12.390	0.208	4.967	5.606	-	23.171	-	-	-	-	-	23.171
C	4.747	2.645	6.372	11.018	-	24.782	-	-	-	-	-	24.782
D	2.750	0.955	2.910	7.346	-	13.961	-	-	-	-	-	13.961
E	0.739	0.232	3.867	3.676	-	8.514	-	-	-	-	-	8.514
F	-	0.089	4.470	9.076	-	13.635	-	-	-	-	-	13.635
G	-	-	-	-	-	-	-	-	-	-	-	-
SLV	-	-	-	0.036	-	0.036	-	-	-	-	-	0.036
N.S. Coke	0.042	-	-	-	-	0.042	-	-	-	-	-	0.042
N.G.	-	-	0.087	-	0.800	0.887	12.686	-	-	0.137	0.018	13.728
Sub-total	21.864	4.129	24.056	38.569	0.800	89.418	12.686	-	-	0.137	0.018	102.259
C. Total(coking+ non-coking)	22.873	21.633	36.743	39.368	0.800	121.417	12.686	3.341	0.648	0.137	0.018	138.242

A. Coking Coals. Ash content of S-I coals is =<15% ; of S-II coals =<18% ; of W-I coals =<21% ; of W-II coals =<24%; of W-III coals =<28%; and of W-IV coals =<35%. Ash plus moisture content of S/C-I coals is =<19%. and of S/C-II coals >19%. S-I and S-II are Steel Grade Prime Coking Coals. W-I, W-II, W-III and W-IV are medium coking coals that need to be prepared in washeries. S/C-I and S/C-II are semi or weakly coking coals.

B. Non-Coking Coals. Ash plus moisture content of A grade coals is =<17% ; of B grade coals =<19% ; of C grade coals =<24% ; of D grade coals =<30% ; of E grade coals =<35% ; and of other coals >35%.

Source : Coal Controllers' Organisation, op cit ref. Table II.1.3.

Table II.1.5 : Share of Open Cast Coal Production

	Total Production (MT)	Production from Open cast Mines (MT)	Share of prod. from OC mines (%)
1960/61	55.67	10.86	19.5
1970/71	72.95	14.68	20.1
1980/81	114.00	41.15	36.1
1982/83	130.60	55.76	42.7
1984/85	147.40	74.00	50.2

Source : 1. R.G. Mahendru, Indian Energy Perspective - Coal, Presented at the 12th Congress of the World Energy Conference, New Delhi, September 1983. 2. Planning Commission.

Table II.1.6 : Trends in Coal Mining

	Operating (as in 1983)	Planned
A. Open Cast Mining		
Coal Production (MMT/year)	=<3	10-14
Overburden (million m^3/year)	=<6	40-55
Average Stripping Ratio (m^3/tonne)	=<2	3-7
Depth (metres)	100-120	Upto 480
OMS (tonnes)	1.6	Upto 10
Electric Power Cons. (kWh/tonne)	3-4	8-10
Size of Rope Shovels (m^3)	Upto 10	12.5, 20
Size of Hydraulic Shovels (m^3)	0.9 to 3	4 to 10
Size of Rear Dumpers (tonnes)	25,35,50	85,120,170
Size of Coal Haulers (tonnes)	=<50	100, 120
Size of Draglines (m^3)	4 to 24	24 to 32
Size of Drills (mm)	=<250	311
B. Underground Mining		
Size of mine (MMT/year)	0.5-0.8	2-3.5
Depth (metres)	100-400	250-700
OMS (tonnes)	0.55	2-3
Electric Power Cons. (kWh/tonnes)	10-15	25-30
Face Operating Voltage (Volts)	550	1100

Source : Mahendru (1983), op cit Ref. Table II.1.5.

Table II.1.7 : An International Comparison of Trends in Output per Manshift (OMS)*

	India	Australia**	USA	W.Germany	Japan	France
1956	0.39	3.79	8.67	0.95	0.50	0.98
1961	0.46	6.76	11.73	1.33	0.71	1.15
1966	0.56	9.12	16.06	1.67	1.18	1.31
1971	0.67	9.91	15.90	2.25	1.74	1.52
1976	0.69	11.65	11.49	2.44	1.62	1.56
1981	0.81	12.59	12.88	2.92	2.03	1.94
1984	0.90	16.40	16.30	3.11	2.12	1.94

* For India, the manshift considered for calculating OMS include work by all personnel engaged in mining operations, administrative/managerial and other services of the coal companies, as well as by manpower engaged in social activities (such as schools, water supply, post and telegraph etc.) in mining townships. In other countries, however, work done by manpower by not employed directly by the coal mining company is not considered while computing OMS.

** For New South Wales only.

Source : Planning Commission.

Table II.1.8. : Average Useful Heating Value of Coals Produced* (kcal/kg)

1975/76	5540
1976/77	5545
1977/78	5525
1978/79	5490
1979/80	5340
1980/81	5210
1981/82	5210

* By Coal India Limited only.

Source : Compiled from various sources.

Table II.1.9 : Washery Statistics

	Supply of Raw Coking Coals ('000t)			Production in 1982 ('000t)		Rated Capacity (tonnes per hour)
	1981/82	1982/83	1983/84	Washed Coal	Middlings	
Dugda I	1668.5	1487.9	1518.1	797	519	600
Dugda II	1740.9	1553.7	1883.5	792	858	500
Patherdih	1394.7	1425.8	1365.5	900	453	300
Sudamdih	850.0	885.0	1086.1	409	328	700
Bhojudih*	1771.5	1741.8	1645.3	1240	26	500
Durgapur (HSL)*	848.0	798.7	648.2	442	243	360
Durgapur (DPL)*	48.2	71.0	72.7	42	11	360
Kargali	2264.1	2331.0	2350.0	1600	419	680
Kathara	2089.0	2152.0	1959.0	1223	600	715
Swang	683.0	774.5	1264.0	562	320	200
Giddi	1742.0	1764.3	1609.4	1000	434	500
Chasnala	1308.3	1329.9	1028.4	764	96	550
Lodna	259.7	265.3	250.5	233	93	70
Jamadoba	1404.9	1360.4	1307.0	923	181	385
W.Bokaro-I	596.2	499.2	532.3	289	186	150
W.Bokaro-II	-	675.0	1345.3	621	448	450
Barora	-	-	288.2	23	110	NA
Moonidih*	-	-	508.7	128	67	NA
Total	18579.0	19115.5	20662.2	11988	5392	7020**

* In West Bengal ; other washeries are in Bihar.
** Excluding Barora and Moonidih Washeries.

Source : Coal Controllers' Organization, op cit Ref. Table II.1.3.

Table II.1.10. : Lignite Statistics
(MMT)

	1981/82	1982/83	1983/84
a. Production (total)	6.306	6.932	7.297
a.1. Tamil Nadu	5.876	6.401	6.679
a.2. Gujarat	0.430	0.531	0.618
b. Despatches (total)	6.295	6.980	7.241
b.1. Tamil Nadu	5.865	6.449	6.623
b.2. Gujarat	0.430	0.531	0.618
c. Stocks at end of year (total)	0.120	0.072	0.079
c.1. Tamil Nadu	0.120	0.072	0.079
c.2. Gujarat	-	-	-

Source: Coal Controllers' Organization, op cit. Ref. Table II.1.3.

II.2 Hydrocarbons

Although data on production and recoverable reserves of crude oil and natural gas are available basin-wise, that of resource prognostications are not. However, from the data available, it becomes clear that there is need to step up exploratory activity. That there has been some progress in this direction during the Sixth Five Year Plan period (1980/81-1984/85) is evident from available data on number of wells and meterage drilled.

Furthermore, although adequate data on the indigenous production of refined products and their total sales/consumption are available, it is not possible to estimate the quantity of net product imports, at least for certain products. For instance, LPG may be obtained either from refinery flue gases or may be extracted from natural gas. It is also imported. However, as data on stock changes at the end of a given time period are not published, it becomes difficult to estimate the quantity imported.

As for refineries themselves, although data on quantity of crude oil feed and capacity utilization are available, data on quality of crude feed (or that of a blend of crudes fed in) are not available. And although the quantity of gross and net crude oil imports are available, the type of crude oils imported are not published. Likewise, although data on refinery losses are usually available, no explanation is given for the wide differences in losses between one refinery and another.

Table II.2.1 : Hydrocarbon Resources and Reserves

A. Prognosticated Resources*	
a. Total (billion tonnes)	17
b1. In offshore areas (%)	63
b2. In onshore areas (%)	37
c1. In Category I basins (%)	60
c2. In Category II basins (%)	30
c3. In Category III basins (%)	10
B. Proved and Indicated Balance Recoverable Reserves	
d1. Crude oil (million tonnes)	510.82
d2. Natural Gas (billion m^3)	478.25

* Excluding Category IV Basins. Category IV basins are those, which on the analogy with similar hydrocarbon bearing basins in the world, may be considered prospective (e.g. Gondwana Basin, Vindhyan Basin, Deccan Syncline).

a. Figure refers to billion tonnes of oil plus oil equivalent of natural gas.

c1. Proved Petroliferous basins with commercial production (eg. Bombay High Offshore Basin, Cambay Basin, and Upper Assam).

c2. Sedimentary Basins with known occurance of hydrocarbons, but from which, no commercial production has yet been obtained (eg. Basins in the Assam-Arakan Fold Belt, Bengal, Andaman and Nicobar, Krishna-Godavari, Cauveri, Western Rajasthan, and Himalayan Foothills.).

c3. Sedimentary Basins in which significant shows of hydrocarbons have not yet been found, but which, on general geological grounds, are considered to be prospective (e.g. Basins in Kerala-Konkan, Saurashtra and Kutch).

Source : (1)Government of India, Seventh Five Year Plan, 1985-90, Vol.II, Planning Commission, New Delhi, 1985. (2) Department of Petroleum, Indian Petroleum and Petrochemical Statistics 1984/85, GOI, New Delhi.

Table II.2.2 : ONGC – Drilling Statistics (1979/80–1984/85)

	Meterage Drilled('000 metres)			No. of Wells		
	E	D	T	E	D	T
A. Onshore						
1979/80	90.6	47.5	138.1	41	28	69
1980/81	81.9	52.5	134.4	39	33	72
1981/82	113.0	97.8	210.8	46	52	98
1982/83	119.7	104.6	224.3	56	58	114
1983/84 (RE)	161.5	121.5	283.0	54	63	117
1984/85 (BE)	221.7	147.8	369.5	72	77	149
B. Offshore						
1979/80	30.8	28.7	59.5	14	12	26
1980/81	35.7	42.1	77.8	14	18	32
1981/82	38.8	72.2	111.0	12	34	46
1982/83	57.0	104.6	161.2	17	47	64
1983/84 (RE)	68.7	153.9	222.6	21	72	93
1984/85 (BE)	87.0	159.6	246.6	27	76	103

E : Exploratory; D : Developmental; T : Total.
RE : Revised Estimates.
BE : Budget Estimates.

Source : Department of Petroleum, Performance Budget, GOI, New Delhi, various issues.

Table II.2.3 : Meterage Drilled by ONGC and OIL*
('000 metres)

	Cumulative upto 1973/74	1974/75 -1979/80	1980/81 -1983/84
A. ONGC			
Onshore	2206.5	801.8	852.5
Offshore	5.9	158.1	573.0
Total	2212.4	959.9	1425.5
B. OIL			
Onshore	NA	281.7	236.6
Offshore	-	2.1	14.8
Total	NA	283.8	251.4

* Includes both developmental and exploratory drilling.

Source : Department of Petroleum, op cit Ref. Table II.2.2.

Table II.2.4 : Production of Crude Oil and Natural Gas

	Crude Oil ('000 tonnes)				Natural Gas (million m^3)				
	Onshore				Onshore				
	Assam*	Gujarat	Offshore	Total	Assam*	Gujarat	Offshore	Gross	Net*
1970/71	3367	3455	-	6822	980	465	-	1445	647
1973/74	3589	3600	-	7189	1195	518	-	1713	762
1975/76	4300	4148	-	8448	1595	773	-	2368	1124
1976/77	4305	4187	406	8898	1558	822	48	2428	1381
1977/78	4534	4155	2074	10763	1717	893	229	2839	1464
1978/79	4085	4238	3310	11633	1518	908	386	2812	1711
1979/80	3578	3766	4422	11766	1385	840	542	2767	1676
1980/81	1714	3808	4985	10507	843	842	673	2358	1522
1981/82	4797	3422	7975	16194	1748	758	1345	3851	2222
1982/83	5001	3185	12877	21063	1829	750	2357	4936	2957
1983/84	5040	3588	17392	26020	1954	748	3259	5961	3399
1984/85	4944	3910	20136	28990	2058	775	4408	7241	4141

* Includes oil and gas production in Arunachal Pradesh beginning 1980/81.

** Net Production = Gross Production - (Gas reinjected + Gas flared).

Source : Department of Petroleum, op cit Ref. Table II.2.2.

Table II.2.5 : Refining Capacity

	Refining Company	Location	Year of commissioning	Throughput Capacity (mtpa) on		
				Date of Comm.	April 1, 1971	April 1, 1985
a.	BPCL	Bombay	1955	2.20	5.25	6.00
b.	BRPL	Bongaigaon	1979	1.00	-	1.00
c.	CRL	Cochin	1966	2.50	2.50	4.50
d.	HPCL	Bombay	1954	NA	3.50	3.50
	HPCL	Vizag	1957	NA	1.50	4.50
e.	IOC	Barauni	1964	2.00	3.00	3.30
	IOC	Digboi	1901	0.50	0.50	0.50
	IOC	Gauhati	1962	0.75	0.80	0.85
	IOC	Haldia	1974	2.50	-	2.50
	IOC	Koyali	1965	2.00	4.30	7.30
	IOC	Mathura	1982	6.00	-	6.00
f.	MRL	Madras	1969	2.50	2.50	5.60
					23.85	45.55

a. Bharat Petroleum Corporation Ltd.
b. Bongaigaon Refineries and Petrochemicals Ltd.
c. Cochin Refineries Ltd.
d. Hindustan Petroleum Corporation Ltd.
e. Indian Oil Corporation.
f. Madras Refineries Ltd.

Source : Dept. of Petroleum, Annual Petroleum and Petrochemical Statistics, GOI, New Delhi, various issues.

Table II.2.6 : Crude Throughput and Refinery Output
('000 tonnes)

Refinery	1980/81		1984/85(P)	
	Crude Run	Production	Crude Run	Production
BPCL (Bombay)	4901	4629	5481	5230
BRPL (Bongaigaon)	52	37	752	614
CRL (Cochin)	2912	2795	872	833
HPCL (Bombay)	3113	2907	3220	3021
HPCL (Vizag)	1319	1208	1249	1157
IOC (Barauni)	504	432	2896	2707
IOC (Digboi)	503	477	531	511
IOC (Gauhati)	639	577	761	710
IOC (Haldia)	2308	2056	2365	2101
IOC (Koyali)	6974	6629	7777	7296
IOC (Mathura)	-	-	6239	5910
MRL (Madras)	2611	2376	3413	3139
Total	**25836**	**24123**	**35556**	**33229**

(P) : Provisional.

Source : Dept. of Petroleum, op cit Ref. Table II.2.5

Table II.2.7 : Trends in Domestic Production and Sales/Consumption of Petroleum Products

	Total (MMT)	Percentage Share of		
		Light Distillates	Middle Distillates	Heavy Ends
A. Production				
1970/71	17.110	17.7	50.0	32.3
1975/76	20.829	17.4	51.7	30.9
1980/81	24.123	17.0	50.2	32.8
1984/85(P)	33.228	19.0	51.8	29.2
B. Sales/Consumption				
1970/71	17.912	15.1	50.5	34.4
1975/76	22.447	16.0	51.9	32.1
1980/81	30.896	14.2	55.2	30.6
1984/85(P)	38.504	16.3	58.1	25.6

(P) : Provisional.

Source : Dept. of Petroleum, op cit, Ref.Table II.2.5.

Table II.2.8 : Production and Sales/Consumption of Petroleum Products ('000 tonnes)

	1980/81		1984/85 (P)	
	Production	Sales/Cons.	Production	Sales/Cons.
A. Light Distillates				
a1. LPG	366	405	873	945
a2. Motor Spirit	1519	1522	2144	2086
a3. Naphtha	2115	2325	3471	3110
a4. Others	101	136	105	147
a5. Sub-total	4101	4388	6593	6288
B. Middle Distillates				
b1. Kerosene	2396	4228	3348	5928
b2. ATF	1001	1125	1312	1337
b3. HSDO	7371	10345	11083	13642
b4. LDO	1108	1122	1253	1210
b5. Others	239	236	228	235
b6. Sub-total	12115	17056	17224	22352
C. Heavy Ends				
c1. Furnace Oil	4041	5406	4104	4159
c2. LSHS/HHS	2079	2067	3797	3631
c3. Total Fuel Oils	6120	7473	7901	7790
c4. Lube Oils	426	570	414	634
c5. Petroleum Coke	86	137	160	233
c6. Bitumen	1082	1064	944	937
c7. Others	193	208	269	270
c8. Sub-total	7907	9452	9688	9864
D. Total	**24123**	**30896**	**33505**	**38504**

(P) : Provisional.

a1 : Liquified Petroleum Gas. Includes production through extraction from natural gas.
b2 : Aviation Turbine Fuel.
b3 : High Speed Diesel Oil.
b4 : Light Diesel Oil.
c2 : Low-Sulphur Heavy Stock/Hot Heavy Stock.
c3 : Furnace Oil + LSHS/HHS.

Source : Dept. of Petroleum, op cit, Ref. Table II.2.5.

Table II.2.9 : Net Oil Imports
('000 tonnes)

	Crude Oil	Refined Products
1970/71	11683	752
1975/76	13624	2048
1978/79	14657	3834
1979/80	16121	4636
1980/81	16248	7253
1981/82	14460	4829
1982/83	12397	4233
1983/84	10445	2856
1984/85(P)	7164	5159

(P) : Provisional.

Source : Dept. of Petroleum, op cit, Ref. Table II.2.5.

Table II.2.10 : LPG Production and Sales
('000 tonnes)

	1980/81	1981/82	1982/83	1983/84	1984/85(P)
A. Production					
a. From Refineries	366	410	406	514	596
b. Extraction from Natural Gas	-	73	169	223	277
c. Total	366	483	575	737	873
B. Sales	405	492	601	746	945
C. Difference*	39	9	26	9	72

* Difference = Net Imports + changes in stocks.
(P) : Provisional.

Source : Dept. of Petroleum, op cit, Ref. Table II.2.5.

II.3 Power

Power supply data are generally well organised. Time series data for existing generation capacity, gross and net generation, grid configuration, inter-state power transfer, and line losses for the utility power supply system are well documented. In addition, captive generation in industrial establishments with captive generation facilities of over 500 kVA capacity are also well documented (although not all such establishments may in fact be covered).

However, owing to a rapid rise in demand, coupled with rather significant slippages in commissioning generation projects, several industrial and commercial establishments have found it profitable to invest in small diesel generating sets, which in certain cases, may be of a capacity as small as 2 to 3 kVA. The State Electricity Boards do keep a record of the sanctions given for installing these captive units, but whether they actually are installed -- or if installed, their usage pattern -- is largely unknown.

Similarly, important data on the power supply reliability is not well documented. Although data on notified power cuts for various categories of consumers may be generally known from the respective State Electricity Boards or other utilities, the actual power supply situation (which takes into account transmission reliability) may differ from one part of a state to another. Information on this aspect is not compiled systematically.

Data presented in Tables II.3.1 through II.3.11 are compiled from various annual issues of "Public Electricity Supply (All India Statistics) : General Review" of the Central Electricity Authority (CEA).

Table II.3.1 : Installed Capacity in Utilities and Non-Utilities -- As on March 31 of each year (MW)

	1971	1974	1977	1980	1983
A. Utilities*					
- Hydro	6383.23	6965.30	9024.90	11383.97	13055.86
- Steam thermal	7508.18	8651.76	11433.15	15991.13	20712.18
- Diesel	229.54	241.00	192.54	164.73	176.23
- Gas	168.00	165.50	178.00	268.00	559.00
- Nuclear	420.00	640.00	640.00	640.00	860.00
- Total	14708.95	16663.56	21468.59	28447.83	35363.27
B. Non-Utilities**					
- Hydro	-	-	2.56	2.61	2.60
- Steam thermal	-	-	1812.71	2041.57	2461.34
- Diesel	-	-	456.26	761.06	1353.45
- Gas	-	-	15.37	54.27	54.27
- Nuclear	-	-	-	-	-
- Total	1562.01	1732.76	2286.90	2859.51	3871.66

* Includes State Electricity Boards, Public Sector Electricity Departments/Government Undertakings, Public Sector Municipalities, and three Private Sector Companies in Gujarat, Maharashtra and West Bengal.

** Includes Public and Private Sector Industries with Captive generation facilities of over 100 kW and those with a contract demand of over 500 kVA but having captive generation capacity of less than 100 kW; as well as Railways.

Table II.3.2 : Installed Capacity in Utilities by Region -- As on March 31 of each year (MW)

	1971	1974	1977	1980	1983
A. **Northern Region**	3152.55	4179.04	5634.28	8224.02	10274.68
- Hydro	1934.74	2200.47	2698.77	3946.38	4441.02
- Steam thermal	1098.03	1599.70	2586.60	3976.90	5321.90
- Diesel	107.28	136.37	106.41	68.24	59.26
- Gas	12.50	22.50	22.50	12.50	12.50
- Nuclear	-	220.00	220.00	220.00	440.00
B. **Western Region**	4023.83	4070.11	5607.05	7808.52	10005.00
- Hydro	1131.32	1037.32	1668.30	1790.30	1810.30
- Steam thermal	2377.60	2536.00	3460.00	5541.00	7478.00
- Diesel	40.91	22.79	4.75	3.22	2.70
- Gas	54.00	54.00	54.00	54.00	294.00
- Nuclear	420.00	420.00	420.00	420.00	420.00
C. **Southern Region**	4034.71	4516.34	5634.22	7207.31	8705.31
- Hydro	2840.35	3080.03	3759.13	4593.23	5683.23
- Steam thermal	1171.50	1412.50	1852.50	2592.50	3000.00
- Diesel	2.86	3.81	2.59	1.58	2.08
- Gas	20.00	20.00	20.00	20.00	20.00
- Nuclear	-	-	-	-	-
D. **Eastern Region**	3305.47	3686.08	4327.52	4866.74	5846.87
- Hydro	409.51	579.93	819.93	906.88	971.98
- Steam thermal	2861.05	3068.56	3469.05	3818.23	4727.28
- Diesel	34.91	37.59	38.54	41.63	47.61
- Gas	-	-	-	100.00	100.00
- Nuclear	-	-	-	-	-
E. **North-Eastern**	192.39	211.99	265.52	341.24	531.41
- Hydro	67.31	67.55	78.77	147.18	149.33
- Steam thermal	-	35.00	65.00	62.50	185.00
- Diesel	43.58	40.44	40.25	50.06	64.58
- Gas	81.50	69.00	81.50	81.50	132.50
- Nuclear	-	-	-	-	-

A. Includes Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh, Chandigarh and Delhi.

B. Includes Gujarat, Madhya Pradesh, Maharashtra, Goa-Daman-Diu, and Dadra and Nagar Haveli.

C. Includes Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Pondicherry and Lakshadweep.

D. Includes Bihar, Orissa, West Bengal, DVC, Andaman & Nicobar Islands, and Sikkim.

E. Includes Assam, Manipur, Meghalaya, Tripura, Arunachal Pradesh, Mizoram and Nagaland.

Table II.3.3 : Annual Gross Generation in Utilities and Non-Utilities (GWh)

	1970/71	1973/74	1976/77	1979/80	1982/83
A. Utilities					
- Hydro	25248	28972	34836	45478	48373
- Steam thermal	27796	34853	49744	55720	77914
- Diesel	114	125	55	53	44
- Gas	251	343	446	500	1910
- Nuclear	2417	2396	3252	2877	2022
- Total	55827	66689	88333	104627	130264
B. Non-Utilities					
- Hydro	-	-	8	15	10
- Steam thermal	-	-	6927	7251	8529
- Diesel	-	-	307	836	1421
- Gas	-	-	40	91	76
- Nuclear	-	-	-	-	-
- Total	5384	6107	7282	8193	10036

Table II.3.4 : Annual Gross Generation in Utilities by Region (GWh)

	1970/71	1973/74	1976/77	1979/80	1982/83
A. Northern Region	11863	16317	23858	29227	37077
- Hydro	6616	9420	11464	15477	18536
- Steam thermal	5211	6333	11288	12610	17988
- Diesel	36	69	10	5	2
- Gas	neg.	8	2	4	-
- Nuclear	-	488	1095	1131	552
B. Western Region	16912	19825	25981	32077	40188
- Hydro	5478	5386	7651	7945	6550
- Steam thermal	8945	12463	16069	22310	31022
- Diesel	15	4	neg.	neg.	neg.
- Gas	57	64	103	76	1145
- Nuclear	2417	1909	2157	1746	1470
C. Southern Region	15710	17574	21714	27032	33682
- Hydro	11679	11930	13077	19354	20247
- Steam thermal	4030	5640	8635	7677	13433
- Diesel	neg.	neg.	1	1	2
- Gas	1	4	1	-	-
- nuclear	-	-	-	-	-
D. Eastern Region	10959	12428	15977	15393	17922
- Hydro	1316	2036	2456	2334	2562
- Steam thermal	9611	10372	13509	12928	15128
- Diesel	32	20	11	28	19
- Gas	-	-	-	102	212
- Nuclear	-	-	-	-	-
E. North-Eastern Region	385	544	803	898	1395
- Hydro	160	200	188	367	478
- Steam thermal	-	45	242	194	344
- Diesel	31	32	33	19	21
- Gas	194	267	341	318	552
- Nuclear	-	-	-	-	-

neg. < 0.5 GWh.

Table II.3.5 : Efficiency of Steam Thermal Stations (1982/83)

Overall Thermal Efficiency(%)	No. of Generating Stations	Aggregate Installed Capacity(MW)	Gross Energy Generation(GWh)	% to total gross Generation
< 10	21*	666.20	216.24	0.28
10 - 15	14	550.88	711.10	0.91
15 - 20	7	930.00	3733.53	4.79
20 - 25	19	4546.10	16962.76	21.77
25 - 30	24	8422.50	33565.52	43.08
> 30	13	5596.50	22724.66	29.17

* Includes 6 power stations having total aggregate capacity of 439.25 MW but nil generation.

Table II.3.6 : Utilities -- Energy Generated, Purchased, Sold and Energy Losses (GWh)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Gross Energy Generation	55827.6	66689.03	88333.31	104627.26	130263.58
b. Energy used in power station auxiliaries	2863.2	3615.43	5333.97	6495.15	9029.25
c. Net Energy Generation	52964.4	63073.60	82999.34	98132.11	121234.33
d. Energy Purchased from Non-utilities	66.3	114.87	79.67	61.51	70.36
e. Energy Imported from other countries	-	-	8.00	6.00	5.92
f. Energy Available for Supply	53030.7	63188.47	83087.01	98199.62	121310.61
g. Energy sold to ultimate consumers in India	43724.2	50246.38	66608.57	78083.62	95588.57
h. Energy sold to other countries	-	10.97	32.11	40.06	78.10
i. Total Energy Sold	43724.2	50257.35	66640.68	78123.68	95666.67
j1. Energy lost in Transmission/ Distribution and Energy Unaccounted for	9306.5	12931.12	16446.33	20075.95	25643.94
j2. Energy Losses(%)	17.5	20.5	19.8	20.4	21.1

e, h : Nepal and Bhutan.

Table II.3.7 : Transmission and Distribution Lines of Utilities -- As on March 31 of each year (Circuit kilometers)

	1970	1974	1977	1980	1983
A. **Northern Region**	301379	416467	508902	665188	830941
of which :					
- 400 kV	-	-	-	762	1484
- 220/230 kV	2745	3695	5558	8434	10289
- 132 kV	8789	10061	12659	15222	18087
B. **Western Region**	249981	343876	441701	624377	768698
of which :					
- 400 kV	-	-	-	690	1781
- 220/230 kV	3188	4192	5796	9797	12875
- 132 kV	5661	9358	11125	13871	15678
C. **Southern Region**	447268	601967	682583	797888	937524
of which :					
- 400 kV	-	-	-	-	-
- 200/230 kV	4603	5247	6828	8121	10577
- 132 kV	3487	3856	3848	3599	4031
D. **Eastern Region**	107230	138690	194188	234700	279175
of which :					
- 400 kV	-	-	-	-	-
- 220/230 kV	705	705	3231	3423	4035
- 132 kV	7857	7611	9069	9514	12108
E. **North-Eastern Region**	11304	17884	22899	29456	48974
of which :					
- 400 kV	-	-	-	-	-
- 220/230 kV	-	93	93	257	257
- 132 kV	665	829	991	1385	1828
F. **All India**	1117162	1518884	1850273	2351609	2865312
of which :					
- 400 kV	-	-	-	1452	3265
- 200/230 kV	11241	13932	21506	30032	38033
- 132 kV	26459	31715	37692	43591	51732

Table II.3.8 : No. of Towns Electrified in Various Population Groups -- As on March 31 of each year

Population Group	1971[a]	1974[a]	1977[b]	1980[b]	1983[b]
< 5000	266	267	294	296	296
5,000 - 9,999	844	846	820	820	820
10,000 - 19,999	819	819	987	987	987
20,000 - 49,999	518	518	652	652	652
50,000 - 99,999	139	139	219	219	219
>=100,000	107	107	151	151	151
Total	2693	2696	3123	3125	3125

a) Towns in population groups as per 1961 census.
b) Towns in population groups as per 1971 census.

Table II.3.9 : No. of Villages Electrified in Various Population Groups-- As on March 31 of each year

Population Group	1971[a]	1974[b]	1977[b]	1980[b]	1983[b]
< 500	31824	52664	72351	95253	140092
500 - 999	26668	42462	54053	67650	86596
1000 - 1999	25887	34994	45150	53381	61864
2000 - 4999	17168	21633	25915	27938	29677
5000 - 9999	2688	3198	4118	4283	4355
>= 10000	704	763	1256	1294	1297
Total	104939	155714	202843	249799	323881

a) Villages in population groups as per 1961 census.
b) Villages in population groups as per 1971 census.

Table II.3.10 : **No. of Consumers and Connected Load -- As on March 31 of each year**

	1971	1974	1977	1980	1983
A. Domestic					
- no. of consumers (`000)	10165.2	13238.2	16288.5	20375.1	26358.3
- Conn. load (MW)	5985.9	7927.0	9557.6	11716.1	15633.0
B. Commercial					
- no. of consumers (`000)	2305.7	2871.0	3494.0	4277.3	5056.4
- Conn. load (MW)	1911.0	2565.8	3797.4	4194.4	4963.7
C. Industrial (LV and MV)					
- no. of consumers (`000)	532.3	713.4	842.3	1051.2	1292.3
- conn. load (MW)	4560.6	5558.0	7902.5	9019.9	12915.7
D. Industrial (HV)					
- no. of consumers (`000)	10.0	11.8	16.1	22.2	17.7
- conn. load (MW)	6383.6	8503.8	10608.9	13600.9	14584.5
E. Public Lighting					
- no. of consumers (`000)	58.3	162.1	120.6	129.3	149.3
- conn. load (MW)	167.7	237.6	277.2	305.5	350.7
F. Traction					
- no. of consumers	69	40	49	60	89
- conn. of load (MW)	417.7	603.8	741.5	783.4	824.8
G. Agriculture					
- no. of consumers (`000)	1570.9	2391.1	3020.9	3880.5	4895.2
- conn. load (MW)	6224.8	9494.2	12053.0	15247.4	18712.3
H. Public Water Works & Sewage					
- no. of consumers (`000)	10.2	20.0	26.4	35.5	50.2
- conn. load (MW)	269.7	410.3	552.5	650.8	855.7
I. Miscellaneous					
- no. of consumers (`000)	12.2	20.9	30.2	57.2	103.6
- conn. load (MW)	309.0	308.4	380.0	605.2	869.1
J. Total					
- no. of consumers (`000)	14665.0	19428.5	23839.0	29828.2	37923.2
- conn. load (MW)	26230.2	35608.9	45870.7	56123.4	69709.4

Table II.3.11 : Peak Demand

Region	Month in which Demand was Max.	Actual Peak Demand (MW)*
A. 1978/79 (April 1, 1978 to March 31, 1979)		
- Northern	January	4691
- Western	December	4486
- Southern	November	4004
- Eastern	August	2240
- North-Eastern	September	158
- All India **	-	15579
B. 1982/83 (April 1, 1982 to March 31, 1983)		
- Northern	January	5767
- Western	February	6200
- Southern	August	5419
- Eastern	October	2861
- North-Eastern	November	298
- All India **	-	20545

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* Figures for peak demand are of actual simultaneous peak demand on the regional system, irrespective of power restrictions.

** Non-coincident aggregate.

II.4 Biomass

Biomass, though abundant in India, is a scattered resource. With an increase in agricultural productivity, human and livestock population, urbanization and industrial output, the production of waste materials (that may be used as a source of energy) has increased. However, the data base in this area is very deficient. The data available is usually "normative" rather than actual -- although the norms themseleves may have been derived from some isolated sample surveys.

There is therefore a need to assess the availability of residues, their method of collection and storage, their chemical composition, calorific content and other characteristics, environmental implications of their utilization, and so forth. Only with such an overall assessment will it be possible to formulate an appropriate policy for biomass utilization.

Table II.4.1: Land Utilization (1976/77)
(million hectares)

a.	Total Geographical Area	328
b.	Area under forest	60
c.	Area not available for cultivation	39
c1.	Barren and unculturable lands	21
c2.	Land put to non-agricultural uses	18
d.	Other uncultivated land excluding current fallow	34
e.	Fallow lands	22
f.	Area under agriculture (net sown area)	143

b. Includes all lands classified as forests under any legal enactment dealing with forests or administered as forests, whether state-owned or private, and whether wooded or maintained as potential forest land.

c1. Includes mountains, deserts etc. Land which cannot be brought under cultivation unless at a high cost are classified as unculturable, whether such land is in isolated blocks or within cultivated holdings.

c2. Includes all land occupied by buildings, roads and railways or under water (e.g. rivers, canals, lakes etc.), as well as other land put to uses other than agriculture.

d. Includes: (i) permanent pastures and other grazing lands; (ii) all cultivated land not included in net sown area, but is used for planting miscellaneous crops (casurina, thatching grass, bamboo bushes) and groves for fuel etc. which are not classified as orchards; and (iii) land cultivated earlier but not for at least five years in succession.

e. Includes land kept fallow in the current year but not for more than five years in succession.

f. Area sown with crops and orchards, counting areas sown more than once in the same year only once.

Source: Ministry of Agriculture, GOI, 1974/75 to 1976/77, Indian Agricultural Statistics, Directorate of Economics and Statistics.

Table II.4.2: Potential Availability of Agriculture Based Biomass

	1950/51	1960/61	1970/71	1981/82
A. Potential Availability of Rice Husk				
- Cropped Area ('000 hectares)	30810	34130	37590	40706
- Rice Production ('000 tonnes)	20580	34570	42220	53593
- Rice Husk Availability ('000 tonnes)	6860	11523	14073	17864
B. Potential Availability of Bagasse				
- Cropped Area ('000 hectares)	1701	2445	2615	3192
- Sugarcane Prod. ('000 tonnes)	57050	103970	126370	183647
- Bagagge Availability ('000 tonnes)	19017	34657	42123	61216
C. Potential Availability of Coconut Shell				
- Cropped Area ('000 hectares)	822	714	1046	1088
- Coconut Production (million tonnes)	3582	4639	6075	5619
- Shell Availability ('000 tonnes)	716	928	1215	1125
D. Potential Availability of Groundnut Shell				
- Cropped Area ('000 hectares)	4496	6463	7326	7448
- Groundnut Production ('000 tonnes)	3426	4812	6111	7239
- Shell Availability ('000 tonnes)	1142	1604	2037	2413
E. Potential Availability of Cotton Stalks				
- Cropped Area ('000 hectares)	5882	7978	7605	7987
- Cotton Prod. ('000 bales of 175 kg.)	2875	4581	4499	7826
- Cotton Stalks Avail. ('000 tonnes)	17646	23934	22815	23962

F. Potential Availability of Jute Sticks				
- Cropped Area ('000 hectares)	571	917	749	827
- Jute Prod. ('000 bales of 180 kg.)	3309	6358	4939	6817
- Jute Sticks Avail. ('000 tonnes)	1713	2751	2247	2480
G. Potential Availability of Maize Cobs				
- Cropped Area ('000 hectares)	3159	4410	5850	5898
- Maize Grain Prod. ('000 tonnes)	1729	4080	7413	6760
- Maize Cobs Avail. ('000 tonnes)	519	1224	2224	2028

A. Rice Husk: 33 % by weight of clean rice.
B. Bagasse: 33 % by weight of sugarcane.
C. Coconut Shell: 10,000 nuts yield about 20 tonnes of shell.
D. Groundnut Shell: 33 % by weight of groundnut produced.
E. Cotton Stalks: 3 tonnes of cotton stalks produced per hectare.
F. Jute Sticks: 3 tonnes of jute sticks produced per hectare.
G. Maize Cobs: 30 % by weight of maize grain produced.

Source: C.P. Vimal & P.D. Tyagi, Energy From Biomass,
Agricole Publishing Academy, New Delhi, 1984.

Table II.4.3: Potential Availability of City Refuse

	Urban Population (million)	City Refuse (million tonnes/year) Total*	Non-Compostable	Compostable**
1970/71	110.2	16.09	9.65	6.44
1975/76	134.5	19.64	11.78	7.86
1980/81	157.7	23.02	13.81	9.21

* 0.4 kg/urban dweller/day (Vimal and Tyagi, 1984).

** 60% is non-compostable; 40% is compostable (Vimal and Tyagi, 1984).

Table II.4.4: Chemical Characteristics of City Refuse

	Population Range of City (millions) < 0.2	0.2-0.5	0.5-2.0	> 2.0
Moisture (%)	22.12	25.05	22.45	31.18
pH	8.18	8.16	8.34	7.68
Organic Matter (%)*	22.02	22.51	21.51	27.57
Carbon (%)*	12.26	12.51	11.95	15.32
Nitrogen (%)*	0.60	0.61	0.56	0.58
Phosphorus (P_2O_5) (%)*	0.71	0.72	0.68	0.59
Potash (K_2O) (%)*	0.71	0.74	0.72	0.68
Calorific Value (kCal/kg)	801	874	867	1140

* On a dry weight basis.

Source: Bhide et al. Indian Journal of Environmental Health, 1973, 17(3); as quoted in Vimal and Tyagi (1984), op cit Ref. Table II.4.2.

Table II.4.5: Area Under Forests (by Composition)
(sq. km.)

	1969/70	1970/71	1971/72	1972/73
A. Coniferous (Soft Wood)				
- Deodar	2421	2954	2988	2040
- Chir	9510	9764	9997	9157
- Kail	3215	3736	3802	3302
- Fir	6536	7012	7080	6846
- Others	7717	7907	7916	12001
- Sub-total	29399	31373	31783	33346
B. Non-Coniferous (Soft and Hard Wood)				
- Sal	80643	80718	80650	80594
- Teak	72975	71003	71269	75041
- Sisso	1698	1717	1335	1363
- Simul	361	458	510	514
- Dipterocarpus	31407	38212	38199	35129
- Others	411584	399718	390617	424231
- Sub-total	598668	591826	582580	616872
C. Coniferous Forests for which details are not available	11752	11752	11752	11752
D. Non-Coniferous Forests for which details are not available	105556	106102	113048	76884
E. Total	745375	741053	739163	738854

Source: Ministry of Agriculture, GOI, Indian Forest Statistics, Directorate of Economics & Statistics, New Delhi, 1978.

Table II.4.6: Livestock Population ('000)

	1972	1977
Cattle	178,341	180,140
Buffaloes	57,426	62,029
Sheep	39,993	40,907
Goats	67,518	75,620
Horses & Ponies	942	916
Mules	75	89
Donkeys	995	978
Camels	1109	1068
Pigs	6896	7647
Other Livestock	44	146
Total	353,338	369,540

Source: Ministry of Agriculture, GOI, Indian Livestock Census, Department of Economics & Statistics, New Delhi, September 1984.

Table II.4.7 : Dung Production in Various States (kg/bovine/day))

Andhra Pradesh	3.6
Bihar	3.6
Gujarat	3.7
Haryana	6.8
Himachal Pradesh	5.3
Karnataka*	2.9
Kerala	2.6
Madhya Pradesh*	2.6
Maharashtra	3.2
Punjab	7.0
Rajasthan**	5.7
Tamil Nadu	5.8
Uttar Pradesh	4.7

* Estimates based on surveys covering only western parts of the state.

** Estimates based on surveys covering only about 2/3rds of the state.

Source: Goel BBPS et al, Indian Journal of Animal Science, 1973, 43; as quoted in Vimal and Tyagi (1984), op cit Ref. Table II.4.2.

Table II.4.8: Heat Potential of Biomass

	Cal. Value* (kCal/kg.)
A. Agricultural Wastes	
Paddy Straw	3000
Rice Husk	3440
Mango Leaves	3390
Groundnut Straw	4200
Sugarcane Bagasse	3800
Wheat Straw	3800
Cotton Stalks	3300
Maize Stalks	4700
Maize Cobs	3500
Bajra Stalks	3850
Gram Straw	3950
Masoor Straw	3810
Moong Straw	3820
B. Forestry Residues	
Wood Wastes	2500-3850
Bark	2500-2850
C. Animal Wastes	
Cowdung	3290
Cowdung cake	3140

* Upper Heating Value; for oven dried biomass.

Source: Vimal and Tyagi (1984), op cit Ref. Table II.4.2.

III. ENERGY DEMAND

III.1 Overview

In trying to identify the determinants of energy demand, economists have studied several issues, including the level of economic development, relative energy consumption levels in the various economic sectors and sub-sectors, major energy consuming activities in a particular sector, type/vintage/cost/other characteristics of energy consuming equipment in use, energy prices, and so on.

To get a good feel of the energy demand aspects obviously entails very large data base requirements. Such data are not usually compiled systematically in developing countries, including India. However, an attempt is made here to present energy and related data for major energy consuming activities in sections III.2 through III.6.

Background data on the composition of India's gross domestic product (GDP) and population are also presented.

Table III.1.1: GDP at Factor Cost by Industry of Origin (Rs. crores, 1970/71 prices)

	1970/71	1975/76	1980/81*	1984/85**
a. Agriculture, forestry and logging, mining and quarrying.	17802	19934	21103	23410
b. Manufacturing, Construction, Electricity, Gas and Water supply.	7594	8782	10935	13278
c. Transport, Communication and Trade.	5912	7461	9548	12131
d. Banking and Insurance, Real estate and ownership of dwellings and business services.	2114	2574	3360	4334
e. Public Administration, Defence and Other Services.	3314	4139	5759	8320
f. Total	36736	42890	50705	61473

* Provisional.
** Quick Estimates.

Source: Government of India, Economic Survey (various issues).

Table III.1.2: Population and Trends in Urbanization

	Total Population (millions)	Urban Population (%)
1951	361	17.3
1961	439	18.0
1971	548	19.9
1981	685	23.7

Source: Centre for Monitoring Indian Economy, Basic Statistics Relating to the Indian Economy, vol.I : All India, Economic Intelligence Service, Bombay.

III.2 Agriculture

Time series data on acreage under a particular crop by district/state and cropping season, area under high yielding varieties, net sown area/gross cropped area, and crop yield are well documented. Likewise, data on the net irrigated area (by source of irrigation), population of agricultural implements and equipment, and the capacity rating of mechanized equipment are also well documented.

However, little information is available on the direct and indirect use of energy. The singular exception is that of electricity sales, annual time series data for which are available at the state level. The use of high speed diesel oil (HSD) and light diesel oil (LDO) for pumping and land preparation is little understood. Only normative data for diesel consumption -- per hour of use of diesel using equipment and the number of hours of use of such equipment are available. For diesel pumpsets, the problem is compounded further, because an unknown fraction are in fact used as back-ups for lift irrigation -- during irrigation periods when power supply for electric pumpsets is not there.

With the available data base, it is also not possible to judge the energy expended by draught animals for lifting water or for land preparation. Similarly, although the sales of inorganic fertilizers (at the state level) are documented, the use of organic manure is not.

Table III.2.1: Cropped and Irrigated Area
(million hectares)

	1951/52	1960/61	1970/71	1980/81
Gross Cropped Area	133.2	152.8	165.8	173.3
Net Sown Area	119.4	133.2	140.8	140.3
Gross Irrigated Area	23.2	28.0	38.2	49.6
Net Irrigated Area	21.0	24.7	31.1	38.8

Source: Ministry of Agriculture (GOI), Directorate of Economics & Statistics, Annual Reports, New Delhi, various issues.

Table III.2.2: Net Irrigated Area by Sources of Irrigation
('000 hectares)

	1950/51	1960/61	1970/71	1978/79*
Government Canals	7158	9170	11972	14270
Private Canals	1137	1200	866	838
Tanks	3613	4561	4112	3918
Tube wells	5978	135	4461	8178
Other wells		7155	7426	8232
Other sources	2967	2440	2266	2525
Total	20853	24661	31103	37961

* Provisional.

Source : Ministry of Agriculture (GOI), Directorate of Economics and Statistics, Indian Agriculture in Brief, New Delhi, Dec. 1982.

Table III.2.3: Number and Area of Operational Holdings (1976/77)

Size Range (hectares)	Number ('000)	Area ('000 hectares)
Below 0.5	30,050	7,009
0.5 - 1.0	14,473	10,501
1.0 - 2.0	14,728	20,905
2.0 - 5.0	14,497	44,989
5.0 - 10.0	5,381	37,067
Above 10.0	2,440	42,873
Total	81,569	163,344

Source: Ministry of Agriculture (GOI), op cit Ref. Table III.2.2.

Table III.2.4: Seasonal Water Requirements of Non-Rice Crops*
(cubic metre per hectare of sown area)

	Kharif (Jul.-Oct.)	Rabi (Nov.-Mar.)	Hot Weather (Mar.-Jun.)
a. Sub-Tropical Zone			
a.1 Hot, Arid	5000-6000	4000-5000	8000-9000
a.2 Hot, Sub-Humid	4500-5500	4000-5000	6000-7000
b. Tropical Zone			
b.1 Hot, Sub-Humid, Humid	4500-5500	5000-6000	6500-7500
b.2 Hot, Semi-Arid	6000-7000	6000-7000	9000-10000
b.3 Hot, Arid	9000-10000	8000-9000	12000-14000

* Assuming 70 % irrigation application efficiency, which is the ratio between water available to the crop, and that delivered by the pump.

a.1 Includes Punjab, Haryana and Uttar Pradesh.

a.2 Includes Assam, Orissa and West Bengal.

b.1 Includes Tamil Nadu, Kerala, and parts of Karnataka and Andhra Pradesh.

b.2 Includes Maharashtra, and parts of Karnataka, Gujarat, Andhra Pradesh and Madhya Pradesh.

b.3 Includes Rajasthan and parts of Gujarat and Madhya Pradesh.

Source: C. Dakshinamurthi, Water Resources of India and their Utilisation in Agriculture, Water Technology Centre, Indian Agriculture Research Institute, New Delhi, 1973.

Table III.2.5: Yield Differential Due to Irrigation

	Yield (Quintals/hectare)		
	Irrigated Land	Unirrigated Land	% yield Differential
Andhra Pradesh	18.6	6.1	205
Bihar	10.9	8.0	36
Gujarat	18.9	6.9	174
Haryana	19.6	6.5	202
Karnataka	23.3	6.3	270
Madhya Pradesh	12.9	7.1	82
Maharashtra	24.5	5.9	315
Punjab	23.6	10.6	123
Rajasthan	13.6	4.5	202
Tamil Nadu	23.1	8.1	185
Uttar Pradesh	20.4	8.6	137

* These are only macro-level data. Farm level variations are therefore missing. Besides, associated relevant information on the use of fertilisers, HYV seeds etc. is not documented.

Source: B.D. Dhawan, Productivity Impact of Irrigation in India, Institute of Economic Growth (Mimeo), Sept. 1983.

Table III.2.6: Population of Lift Irrigation Devices ('000)

	Electric Pumpsets	Diesel Pumpsets	Animal Powered Water lifts
1950/51	21	66	3778
1960/61	200	230	4141
1968/69	1090	720	4675
1973/74	2430	1750	3682
1977/78	3300	2350	3505
1979/80	3950	2650	3326

Source: T.G.K. Charlu and D.K. Dutt, Ground Water Development in India, Rural Electrification Corporation, New Delhi, 1982.

Table III.2.7: Population of Land Preparation Equipment (hundreds)

	1972	1977
a1. Agricultural Tractors (< = 35 HP)	972	1872
a2. Agricultural Tractors (36-50 HP)	475	701
a.3 Agricultural Tractors (> 50 HP)	98	179
b.1 Power Tillers	172	160
c.1 Crawler Tractors (< = 75 HP)	152	163
c.2 Crawler Tractors (> 75 HP)	32	37

Source: Ministry of Agriculture (GOI), Indian Livestock Census 1977, New Delhi, 1984.

Table III.2.8: Population of Livestock Used for Work (thousands)

	1972	1977
a. **Cattle**		
- male	72562	73227
- female	2074	2047
b. **Buffaloes**		
- male	7612	7934
- female	369	339

Source: Ministry of Agriculture (GOI), op cit Ref. Table III.2.7.

Table III.2.9: Use of Electric Pumpsets

	1970/71	1973/74	1976/77	1979/80	1982/83
a. No. of pumpsets energized ('000)	1629.4	2441.6	3029.2	3965.8	4973.3
b. Connected Load (MW)	6224.8	9494.2	12053.0	15247.4	18712.3
c. Electricity Cons. (GWh)	4470.23	6310.21	9620.63	13452.00	17816.84
d. Average capacity of pumpset (hp)	5.03	5.12	5.24	5.06	4.95
e. Electricity cons. per pumpset (kWh)	2743	2584	3176	3392	3640
f. Electricity cons. per unit of connected load (kWh/kW)	718	665	798	882	952

Source: CEA, Public Electricity Supply (All India Statistics) : General Review, New Delhi, various issues.

Table III.2.10: Normative Data for Diesel Pumpsets and Land Preparation Equipment

A. Diesel Pumpsets	
a.1 average capacity	7 HP
a.2 diesel cons. rate	0.2 kg of HSD per BHP-hour
a.3 Annual Usage	1000 hours
B. Land Preparation Equipment	
b.1 Agricultural Tractors	
- average rating	30 hp
- diesel cons. rate	2.7 litres/hour
- annual usage	1000 hours
b.2 Power Tillers	
- average rating	8.5 hp
- diesel cons. rate	1.25 litres/hour
- annual usage	1000 hours
b.3 Crawler Tractors	
- average rating	65 hp
- diesel cons. rate	6.5 litrees/hour
- annual usage	1000 hours

Source: Advisory Board on Energy (GOI), Towards a Perspective on Energy Demand and Supply in India in 2004/05, May 1985.

III.3 Industry

Industry is a major energy consuming sector in India. However, the data base is woefully inadequate and out-of-date. It is anticipated that industry-wise data for 1978/79 (where industrial categories are upto a 4-digit level of classification as per the SIC system), on industrial output and energy and other inputs, will become available shortly. The most recent period for which such data are available today, is 1973/74. In contrast, summary results (for industries classified upto a 3-digit level as per the SIC system) are also available for 1980/81. The summary results however, present all energy consumption data only in monetary terms. As energy prices vary from state to state, and at least for coal, from one part of a state to another, it is not possible to use such data meaningfully for analytical work.

Where time series data are available in physical units, the classification of industries for which coal consumption data are available, is not consistent with that for which petroleum products or/and electric power consumption data are available. This makes it difficult even to estimate energy consumption intensities of various industrial categories, except at very aggregate levels of classification.

Furthermore, consumption of fuelwood and charcoal -- which are used particularly in the unregistered manufacturing sector -- is not documented. And estimates for energy consumption at the process level (by major energy consuming processes) may be available only at the plant level -- again for relatively few units where extensive energy audits have been conducted.

Table III.3.1(a) : Value Added from Manufacturing -- Registered Sector (Rs. million, 1970/71 prices)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Food Products	2861.5	2047.9	2891.5	3346.6	4545.2
b. Beverages, tobacco and tobacco products	991.1	798.5	1422.7	1222.7	1201.8
c. Textiles	5973.0	7796.1	7703.0	10228.7	9858.2
d. Wood & Wood Products	309.4	270.8	266.2	298.2	246.8
e. Paper & Paper Products	1495.9	1524.7	1608.3	1756.0	1715.4
f. Leather, Leather & Fur Products	226.0	151.2	198.4	208.4	245.1
g. Rubber, Plastic, Petroleum and Coal Products	1289.0	1157.3	1738.1	1746.5	2380.3
h. Chemicals & Chemical Products (excluding coal & petroleum)	3670.7	4817.2	5212.6	6979.4	7758.9
i. Non-metallic mineral products	1139.9	1166.6	1286.3	1387.5	2000.2
j. Basic Metal & Alloy Industries	2845.1	3079.2	4188.2	4037.6	4972.4
k. Metal Products and Parts (excluding Machinery, Transport Equipment)	945.4	1087.2	1120.8	1369.7	1305.9
l. Machinery, Machine tools, and parts (excluding Electrical Machinery)	1938.6	2433.9	3276.8	3470.8	4120.7
m. Electrical Machinery, Appliances and Apparatus.	1821.3	2707.2	2936.5	3517.6	5346.6
n. Transport Equipment & Parts	2439.6	2577.3	2839.9	3206.7	4302.4
p. Miscellaneous Manufacturing Industries	1865.2	1562.1	1531.6	1610.4	2644.0
q. Repair Services	-	639.7	976.9	800.6	909.9
r. Net Value Added	28740.0	32769.3	38054.4	43912.2	50736.8
s. Consumption of Fixed Capital	5315.4	5279.1	5290.5	6473.7	7328.8
t. Gross Value Added	34055.4	38048.4	43344.9	50385.9	58065.6

Source : Central Statistical Organization, National Accounts Statistics, GOI, New Delhi, various issues.

Table III.3.1(b) : Value Added from Manufacturing Sector -- Unregistered Sector (Rs. million, 1970/71 prices)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Food Products	1841.1	1835.6	1946.7	1962.5	2326.7
b. Beverages, tobacco and tobacco products	1040.9	982.6	1513.5	1543.6	1823.1
c. Textiles	4461.1	5366.7	6029.3	7795.5	8930.1
d. Wood & Wood Products	2204.3	2288.1	2695.1	2504.4	1920.2
e. Paper & Paper Products	510.6	556.6	614.7	867.9	995.5
f. Leather, Leather & Fur Products	690.7	697.6	748.6	780.5	844.5
g. Rubber, Plastic, Petroleum and Coal Products	182.0	247.0	275.6	315.6	372.2
h. Chemicals & Chemical Products (excluding coal & petroleum)	583.7	730.8	889.8	1012.3	1197.5
i. Non-metallic mineral Products	934.2	1086.5	1503.7	1666.5	1912.5
j. Basic Metal & Alloy Industries	46.2	43.7	70.4	66.5	78.0
k. Metal Products and Parts (excluding Machinery & Transport Equipment)	1177.2	1379.6	1459.1	1749.5	1750.6
l. Machinery, Machine tools and parts (excluding Electrical Machinery)	637.5	866.9	843.3	1015.9	1177.2
m. Electrical Machinery, Appliances and Apparatus	362.7	450.1	478.2	576.4	626.8
n. Transport Equipment and Parts	534.6	608.3	727.7	743.2	836.6
p. Miscellaneous Manufacturing Industries	1325.8	1479.6	1556.8	2274.6	1676.9
q. Repair Services	1060.3	1321.1	1343.4	1542.8	1736.8
r. Net Value Added	17453.6	19746.0	22354.0	26000.6	28205.2
s. Consumption of Fixed Capital	720.3	814.2	981.5	1134.4	1222.4
t. Gross Value Added	18173.9	20560.2	23335.5	27135.0	28766.7

Source : Central Statistical Organization, op cit Ref. Table III.3.1 (a).

Table III.3.2 : Production of Selected Industries

	1970/71	1973/74	1976/77	1979/80	1982/83	1984/85*
a. Metallurgical Industries						
- Pig iron (million t)	6.99	7.00	10.02	8.58	9.58	9.24
- Finished steel (million t)	4.64	4.47	6.80	6.90	8.05	7.78
- Aluminium ('000 t)	168.8	147.9	208.7	191.9	211.5	276.0
- Blister Copper ('000 t)	9.3	12.7	23.7	22.5	35.8	39.7
b. Chemical & Allied Industries						
- Nitrogenous fert. ('000 t)	830	1060	1900	2226	3424	3917
- Phophatic fert. ('000 t)	229	319	474	757	980	1264
- Soda ash ('000 t)	449	480	571	556	635	817
- Caustic Soda('000 t)	371	419	497	550	577	684
- Paper & Paper board ('000 t)	755	776	899	1058	1205	1361
- Cement (million t)	14.3	14.7	18.8	17.6	23.3	29.5
C. Textile Industries						
- Jute textiles ('000 t)	1060	1074	1186	1137	1338	1370
- Cotton cloth (million m.)	7602	7946	7682	7533	7953	9040
- Mixed/blended cloth (million m.)	170		716	1529	1293	1278
- Artificial fibres (million m.)	951	NA	902	1366	1368	1696
D. Food Industries						
- Sugar ('000 t)	3740	3948	4943	3859	8232	6143
- Vanaspati ('000 t)	558	449	541	618	886	930
- Salt ('000 t)	5568	NA	4531	6484	7823	8304
E. Engineering Industries						
- Machine tools (million Rs.)	430	673	1163	1652	2699	3028
- Automobiles ('000)	87.9	99.8	91.3	104.6	151.4	196.2
- Power transformers (million kVA)	8.09	12.42	15.09	18.63	18.60	25.45
- Electric motors (million HP)	2.72	3.24	3.68	3.74	4.81	4.93

Source : Government of India, Economic Survey, various issues.

Table III.3.3 : Electricity Use in Industry
(GWh)

	1970/71	1973/74	1976/77	1979/80	1982/83
Aluminium (Primary)	3307.0	2756.3	3928.9	3699.5	3923.5
Aluminium (Secondary)	68.5	69.4	91.6	83.5	152.3
Cement (Primary)	1335.8	1219.6	2043.9	1734.2	2215.4
Cement (Secondary)	35.5	64.2	296.2	301.5	301.5
Chemicals	1613.6	1544.6	3107.8	5011.3	4718.7
Collieries	601.7	790.3	699.7	1461.8	1722.5
Fertilizer	2531.4	3114.8	4302.2	4256.4	4703.5
Iron & Steel (Primary)	2860.5	3433.0	4554.2	4445.6	4421.9
Iron & Steel (Secondary)	334.3	362.6	925.7	1321.5	1585.5
Jute	659.8	651.5	680.4	700.2	761.3
Mining & Quarrying	61.7	43.9	61.5	66.5	88.3
Oil & Petroleum	432.4	474.1	634.0	759.4	865.8
Paper	899.1	1058.9	1335.2	1617.2	2199.5
Sugar	442.7	441.3	687.3	824.0	1045.4
Textile	3950.5	4055.6	5123.9	5743.2	5909.4
Other Industries	1864.7	2439.6	4438.7	4493.6	6204.2
Total Electricity use in industries mentioned above*	20999.2	22519.7	32911.2	36519.4	40818.7
Total Electricity sales from utilities**	29579.1	32481.4	41605.6	45955.5	53063.8

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* This includes net energy purchased from utilities and captive generation (at least for some industrial units that have captive generation capacity of 100 kVA or more).

** The discrepancy between total electricity sales from utilities, and total electricity use in industry indicates that substantial quantum of electrical energy use is not monitored.

Source : CEA, Public Electricity Supply (All India Statistics) : General Review, New Delhi, various issues.

Table III.3.4 : Fuel Oils Use in Industry*
('000 tonnes)

	1976/77	1979/80(a)	1982/83	1984/85(b) (April-Dec.)
Aluminium	136	122	87	87
Cement	42	154	41	48
Ceramics and Glass	173	185	189	136
Chemicals and Allied	783	811	1016	860
Engineering (Mech. & Elect.)	265	250	209	143
Fertilizers	464	755	1553	1077
Iron & Steel	479	188	533	270
Mining & Quarrying	195	268	110	90
Sugar	51	41	21	14
Textile & Fibre	570	430	334	320
Other Industries	483(c)	691(c)	216(d)	278(d)
Total	3641	3895(e)	4309	3323

* Furnace Oil, LSHS and HHS. Excludes Fuel Oils used for power generation.

a) Furnace Oil only.
b) Provisional.
c) Includes DGS & D.
d) Excludes DGS & D.
e) In addition, about 576,000 tonnes of LSHS/HHS were used in 1979/80, of which, 243,000 tonnes was used in the Iron & Steel Industry alone.

Source : Dept. of Petroleum, Indian Petroleum and Petrochemical Statistics, GOI, New Delhi, various issues.

Table III.3.5 : Petroleum Products Use in Industry (Excluding Fuel Oils) ('000 tonnes)

	1976/77	1979/80	1982/83	1984/85(a)
Naphtha	2183	2413	2958	3110
- Fertilizers	1793	1914	2282	2313
- Petrochemicals	378	494	658	769
- Other industries	12	5	18	28
HSD	610(b)	1097(c)	876	689(e)
LDO	877(b)	1103(d)	302	259(e)
Industrial Lubes(f)	206	237	235	NA
LPG	52	56	70(g)	110(g)

a) Provisional.
b) Includes HSD/LDO used for power generation, plantation/food processing, agriculture retail trade and DGS & D sectors.
c) Includes HSD used for power generation.
d) Includes LDO used for plantation/food processing.
e) April to December only.
f) Includes spindle oil, transformer oil, axle oil, cylinder oil, turbine/hydraulic oil, and other lube oils.
g) Includes LPG used in commercial sector also.

Source : Dept. of Petroleum (GOI), op cit Ref. Table III.3.4.

Table III.3.6 : Coal Consumption in Industry
(million tonnes)

	1973/74	1976/77	1979/80	1982/83
Steel and Washery	13.78	20.34	19.86	22.82
Electricity(a)	16.64	26.85	30.03	49.52
Cement	3.65	4.97	3.87	6.10
Cotton	1.78	2.41	1.99	2.94
Jute	0.14	0.18	0.14	0.17
Paper	1.00	1.75	1.54	2.50
Brick(b)	1.70	4.33	0.54	0.68
Collieries' Cons.	2.77	3.29	3.57	4.37
Other Industries(c)	17.65	18.54	29.31	27.78
Total	59.11	82.66	90.85	116.88

a) Excludes Middlings.
b) Includes Supply by Rail only.
c) Includes coal used for making hard-coke, but which is not used in the steel industry.

Source : Coal Controller's Organization, All India Annual Coal Statistics 1983/84, GOI, Calcutta.

Table III.3.7 : Fuel Consumption for Power Generation

	1970/71	1973/74	1976/77	1979/80
A. Steam Thermal				
- Coal ('000 tonnes)[a]	14569.4	18306.3	28271.6	32586.1
- Lignite ('000 tonnes)	2543.0	2875.0	3127.0	2449.3
- Fuelwood ('000 tonnes)	15.4	11.7	14.4	14.0
- Furnace Oil ('000 kl)	889.0	1404.5	1199.2	1617.4
- Light Diesel Oil ('000 kl)	-	4.4	362.9	251.9
- LSHS/HHS ('000 tonnes)	391.6	353.2	387.2	479.9
- Natural gas (million cu.m.)	152.2	153.8	172.0	155.6
- Refinery gas ('000 tonnes)	4.8	1.0	NA	184.9
B. Gas Stations				
- Natural Gas (million cu.m.)	108.8	169.2	172.0	190.3
- Diesel Oil ('000 kl)	0.3	6.0	0.9	45.2
- LSHS ('000 tonnes)	-	-	-	-
C. Diesel Stations				
- Diesel Oil ('000 kl)	39.3	41.0	20.0	18.6

a) Includes middlings.

Source : CEA, op cit Ref. Table III.3.3.

III.4 Transport

Although extensive data are compiled for the rail transport sub-sector, the same cannot be said for road transport -- the other major mode of transport in India.

For rail transport, the share of steam, diesel and electric traction in total rail traffic is documented, although the relative shares of the three types of traction for passenger and freight traffic separately are not.

However, for road transport, the only reliable data available pertain to vehicle fleet size (by type of vehicle) and HSD/petrol sales. Normative fuel consumption estimates for various types of vehicles are also available. As buses and trucks both run on HSD, it is difficult even to estimate the average annual utilization of: (i) passenger carrying intra-city and inter-city buses; and (ii) freight carrying trucks. Likewise, the relative share of consumption of petrol in 4-wheeled vehicles (cars and jeeps) and 2/3 wheelers is also difficult to estimate -- and the relative role of private vs. public modes of road passenger transport is also not fully understood. Furthermore, little is known about the usage pattern of bicycles and bullock carts.

As for water and air traffic, published data again are rather deficient, but it is also clear that these two modes of transport have until now played only a limited role in India.

Table III.4.1 : Value Added in Transport Sector
(Rs. million, 1970/71 prices)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Total	**13633.7**	**15155.3**	**20423.2**	**23777.9**	**28436.5**
b. Railways	5220.0	5015.3	7000.4	7168.8	7018.8
c. Road	6293.2	7494.2	8728.4	11315.7	15002.1
d. Water	1191.7	1457.5	2021.1	1858.0	1991.1
e. Air	480.8	741.3	974.6	1485.5	1983.5
f. Service Incidental to Transport	124.6	136.1	1019.2	1145.6	1658.0
g. Storage	323.4	310.9	679.5	804.3	783.0

Source : Central Statistical Organisation, National Accounts Statistics, GOI, New Delhi, various issues.

Table III.4.2 : Electrified and Non-Electrified Rail Track
(Kilometres)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Total Route-kilometres	**59790**	**60234**	**60666**	**60890**	**61385**
a.1 Broad Gauge	29449	30210	30873	31239	32624
a.2 Metre Gauge	25865	25548	25512	25370	24515
a.3 Narrow Gauge	4476	4476	4281	4281	4246
b. Total Track-kilometres	**71669**	**74104**	**74839**	**75450**	**76197**
b.1 Broad Gauge	40825	42756	43743	44410	46309
b.2 Metre Gauge	26362	26873	26816	26759	25642
b.3 Narrow Gauge	4482	4476	4281	4281	4246
c. Electrified Route-km	**3420**	**4191**	**4720**	**4820**	**5815**
c.1 Broad Gauge	NA	4024	4553	4654	5649
c.2 Metre Gauge	NA	166	166	166	166
d. Electrified Track-km	**NA**	**8401**	**9373**	**9562**	**11058**
d.1 Broad Gauge	NA	8181	9152	9341	10838
d.2 Metre Gauge	NA	221	221	221	221

Source : Railway Board (GOI), Indian Railways : Annual Statistical Statements, various issues.

Table III.4.3 : Number of Operating Locomotives (As on March 31 of each year)

	1971	1974	1977	1980	1983
Total	**11158**	**11126**	**11095**	**11073**	**10087**
- steam	9387	8847	8345	7856	6292
- diesel	1169	1610	1903	2243	2638
- electric	602	669	847	974	1157

Source : Railway Board (GOI), op cit Ref. Table III.4.2.

Table III.4.4 : Rail Freight Traffic (net million t-km)

		1970/71	1973/74	1976/77	1979/80	1982/83
a.	**Revenue Earning Traffic**	**110698**	**109391**	**144031**	**144559**	**167781**
a.1	Coal	27837	26587	38756	35340	47893
a.2	Raw material for steel plants	2708	2675	4639	4482	5380
a.3	Pig iron and finished steel from steel plants	6201	6179	9882	8063	10093
a.4	Iron ore for export	5492	4275	6408	6188	5761
a.5	Cement	6990	6368	9170	7442	9160
a.6	Food grains	14505	16322	18757	23474	30417
a.7	Fertilizers	3808	4001	7225	9240	8252
a.8	Mineral Oils	5264	6373	7552	10398	11212
a.9	Other commodities	37891	36612	41641	39933	39614
b.	**Non Revenue Earning Traffic**	**16662**	**12963**	**12725**	**11437**	**9986**
c.	**Total Traffic**	**127358**	**122354**	**156756**	**155995**	**177767**

Source : Railway Board (GOI), op cit Ref. Table III.4.2.

Table III.4.5 : Rail Passenger Traffic

		Units	1970/71	1973/74	1976/77	1979/80	1982/83
a.	**Passengers Carried**	million	2431	2654	3300	3505	3656
a.1	Suburban	"	1227	1437	1802	1903	2029
a.2	Non-suburban	"	1204	1217	1498	1602	1627
b.	**Passenger Traffic**	million p-km	118120	135663	163836	198643	226931
b.1	Suburban	"	23052	28037	37082	38730	45789
b.2	Non-suburban	"	95068	107627	126754	159913	181142

Source : Railway Board (GOI), op cit Ref. Table III.4.2.

Table III.4.6 : Total Rail Traffic and Energy Consumption

		Units	1970/71	1973/74	1976/77	1979/80	1982/83
a.	**Total Traffic**	billion gross t-km	390.34	377.14	469.28	468.77	521.87
a.1	Freight and non-suburban passenger traffic	"	381.43	366.28	456.50	455.08	507.23
	- steam	%	47.6	39.3	30.9	23.3	15.6
	- diesel	%	36.0	43.1	46.7	54.7	57.4
	- electric	%	16.4	17.6	22.5	22.0	27.0
a.2	Suburban pass. traffic	billion gross t-km	8.91	10.86	12.78	13.69	14.64
b.	**Energy Consumption**						
b.1	Freight and non-suburban passenger traffic						
	- coal	MMT	14.3	12.7	12.2	11.4	9.4
	- furnace oil	'000 t	NA	63	76	68	51
	- diesel oils	'000 kl	569	681	847	981	1227
	- electricity	GWh	NA	977	1447	1574	1876
b.2	Electricity for suburban passenger traffic	GWh	372	407	492	578	608

Source : Railway Board (GOI), op cit Ref. Table III.4.2.

Table III.4.7 : Road Length
('000 km)

		1961	1971	1974	1977	1980
a.	**Total Road Length**	**524.5**	**917.9**	**1171.3**	**1307.8**	**1494.1**
a.1	National Highways	22.5	23.8	29.1	29.1	29.5
a.2	State Highways	-	56.8	87.6	92.2	95.2
a.3	Panchayat Raj Roads	197.2	357.5	502.1	557.7	645.5
a.4	Urban Roads	46.4	72.1	91.3	105.0	114.2
a.5	Project Roads	-	130.8	157.1	163.2	197.5
a.6	Other Roads	258.4	276.9	304.1	360.6	412.2
b.	**Surfaced Road Length**	**263.0**	**397.9**	**498.8**	**571.7**	**648.1**
b.1	National Highways	21.0	23.3	28.6	28.8	29.3
b.2	State Highways	-	51.7	81.9	86.5	90.3
b.3	Panchayat Raj Roads	35.9	64.8	90.4	104.1	126.0
b.4	Urban Roads	46.4	53.4	66.3	78.2	81.2
b.5	Project Roads	-	6.1	12.4	15.6	22.1
b.6	Other Roads	159.7	198.6	219.2	258.5	299.2

Source : Ministry of Shipping and Transport, Basic Road Statistics of India 1981/82, GOI, New Delhi.

Table III.4.8 : Population of Registered Motor Vehicles -- As as on March 31 of each year ('000)

	1961	1971	1974	1977	1980	1983
All Vehicles	**664.5**	**1865.3**	**2327.1**	**3260.1**	**4514.0**	**6718.5**
2 Wheelers	88.4	575.9	838.5	1414.9	2115.3	3511.9
Cars/Taxis/Jeeps	309.6	682.5	767.6	877.7	1054.4	1351.2
Buses	56.8	93.9	104.9	118.9	140.3	177.8
Trucks	167.6	342.6	323.3	383.1	472.1	647.6
Others	42.1	170.4	292.8	465.6	731.9	1024.5

Source : Ministry of Shipping & Transport, Motor Transport Statistics, (1981/82 and 1982/83), Transport Res. Div., GOI, New Delhi, Jan. 1985.

Table III.4.9 : Road Traffic

	Units	1960/61	1965/66	1970/71	1973/74	1976/77
a. Freight Traffic	billion t-km	35	55	66	67	76
b. Passenger Traffic	billion p-km	57	95	169	208	235

b. Includes intra-city and inter-city passenger traffic.

Source : Planning Commission, Report of the National Transport Policy Committee, GOI, New Delhi, 1980.

Table III.4.10 : Petroleum Products Consumption for Road Transport ('000 tonnes)

	1970/71	1973/74	1976/77	1979/80	1982/83
Motor Gasoline	1453	1521	1316	1480	1722
High Speed Diesel	NA	4229	5267	7765	9267
Total	NA	5452	7106	9712	10403

Source : Dept. of Petroleum, Annual Petroleum and Petrochemical Statistics, GOI, New Delhi, various issues.

Table III.4.11 : Trends in Relative Rail and Road Traffic Levels

	Units	1960/61	1965/66	1970/71	1973/74	1976/77
a. Freight Traffic (Rail + Road)	**billion t-km**	**122.7**	**171.9**	**193.4**	**189.4**	**232.8**
- Rail	%	71.5	68.0	65.9	64.6	67.4
- Road	%	28.5	32.0	34.1	35.4	32.6
b. Passenger Traffic (Rail + Road)	billion p-km	134.6	191.3	287.1	343.6	398.8
- Rail	%	57.7	50.3	41.1	39.5	41.1
- Road	%	42.3	49.7	58.9	60.5	58.9

Source : Planning Commission, op cit Ref. Table III.4.9.

Table III.4.12 : Coastal Fleet and Capacity -- As on March 31 of each year.

		1961	1971	1974	1977	1980
a.	**Number of Vessels**	**104**	**62**	**61**	**75**	**58**
a.1	Dry Cargo Vessels	101	44	46	56	38
a.2	Oil Tankers	3	5	5	9	10
a.3	Passenger-cum-cargo vessels	-	13	10	10	10
b.	**Gross Registered Tonnage ('000 GRT)**	**362**	**218**	**279**	**428**	**254**
b.1	Dry Cargo Vessels	338	139	201	312	128
b.2	Oil Tankers	24	49	52	88	98
b.3	Passenger-cum-cargo vessels	-	30	26	28	28

Source : Ministry of Shipping and Transport, Economic Statistics of Indian Coastal Shipping Industry 1980/81, GOI, New Delhi.

Table III.4.13 : Coastal Shipping -- Freight and Passenger Traffic

	Units	1961	1971	1974	1977
a. Freight (total)	'000 tonnes	5430	4370	4380	3290
a.1 Coal	"	1370	510	490	660
a.2 Salt	"	470	520	480	110
a.3 Other Dry Cargo	"	1500	610	500	130
a.4 Wet Cargo	"	2090	2730	2910	2390
b. Passenger Carried	'000	960	540	380	NA

Source : Planning Commission, op cit Ref. Table III.4.9.

Table III.4.14 : Fuel Deliveries Made to Coastal and International Bunkers ('000 tonnes)

		1970/71	1973/74	1976/77	1979/80	1982/83
a.	**Coastal Bunkers (total)**	**240.9**	**187.3**	**211.3**	**196.7**	**301.0**
a.1	Furnace Oil	196.9	144.0	153.1	126.4	172.2
a.2	High Speed Diesel	22.4	23.7	32.2	41.9	81.0
a.3	Light Diesel Oil	21.6	19.6	26.0	28.4	47.8
b.	**International Bunkers (total)**	**234.3**	**209.3**	**237.2**	**216.6**	**144.3**
b.1	Furnace Oil	207.9	179.9	166.9	135.8	85.0
b.2	High Speed Diesel	6.4	4.8	19.9	17.7	17.0
b.3	Light Diesel Oil	20.0	24.6	50.4	63.1	42.3

Source : Dept. of Petroleum, op cit Ref. Table III.4.10.

Table III.4.15 : Air Traffic

	Units	1970/71	1973/74	1976/77	1979/80	1982/83
a. **Revenue passenger carried**	'000	2157.8	2512.6	3806.9	5382.6	6890.1
- Indian Airlines (domestic)	"	2047.6	2378.4	3631.5	5009.5	6406.0
- Indian Airlines (international)	"	75.0	101.1	152.2	313.3	441.0
- Air India (domestic)	"	35.2	33.1	23.2	21.1	16.1
b. **For Indian Airlines Only**						
- Revenue Passenger-km	millions	1545.04	1904.46	2926.83	4199.36	5408.18
- Available seat-km	millions	2017.64	2700.73	4128.78	5720.33	7965.39
- Passenger load factor	%	75.5	70.5	70.9	73.4	67.9

Source : Indian Airlines, Annual Reports, various issues.

Table III.4.16 : ATF Offtake
('000 tonnes)

	1970/71	1973/74	1976/77	1979/80	1982/83
Total Offtakes	689	800	956	1144	1145
- Indian Airlines	NA	NA	NA	NA	286
- Air India	NA	NA	NA	NA	163
- Foreign Airlines	NA	NA	NA	NA	380
- Other	NA	NA	NA	NA	316

Source : Dept. of Petroleum, op cit Ref. Table III.4.10.

III.5 Residential Sector

As traditional fuels (firewood, charcoal, dungcakes, crop-residues etc.) are a significant fraction of the energy used in households, the data base is understandably quite inadequate. However, some indicative data, gathered through surveys, are available.

It is important to note that such surveys do not often provide good estimates even regarding use of "commercial" energy sources such as soft-coke, kerosene, LPG and electricity--as seen by comparing survey estimates with production and sales data. And as for traditional fuels, the situation is worse, because the data presented in survey reports are not based on actual measurements, but are based solely on the "impressions" of the quantity used.

This is not to say that surveys do not provide any useful information -- but only that information thus gathered may be considered to be only of a qualitative nature. For instance, the very fact that several surveys have indicated a general increase in per capita energy consumption with rise in expenditure levels is an important finding.

It is known that energy consumption is a function of the utilization pattern of a particular device/appliance for a specific end-use. The surveys usually do not provide much information regarding these aspects. In fact, only production data on such household appliances/devices is available. And that too may not be accurate because: (i) available data may not include the production/output of certain small manufacturers; and (ii) a certain unknown fraction of the population of devices may in reality be used in commercial establishments.

Table III.5.1 : Index of Per-Capita Energy Consumption

(a) For 1973/74*

Monthly per-capita expenditure class (Rs.)	Index	
	Rural	Urban
0 - 21	66	48
21 - 28	80	61
28 - 43	90	82
43 - 75	101	96
> = 75	138	125
All classes	100	100

(b) For 1978/79**

Annual Household Income Category (Rs.)	Index	
	Rural	Urban
0 - 3000	98	86
3001 - 6000	96	95
6001 - 12000	112	113
12001 - 18000	125	134
> 18000	127	133
All Classes	100	100

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* **Source:** National Sample Survey 1973/74, 28th Round; as quoted in Government of India, Report of the Working Group on Energy Policy, New Delhi, 1979.

****Source:** National Council for Applied Economic Research, Domestic Fuel Survey With Special Reference to Kerosene (1978/79), New Delhi, 1981.

Table III.5.2: Estimates of Annual Per-Capita Energy Consumption in Rural Areas

	Units	1962(a)	1963/64(a)	1973/74(a)	1978/79(b)
A. Commercial Fuels					
- Coal/Soft-coke	kg	3.8	5.2	6.8	2.3
- Kerosene (total)	litre	5.8	4.4	8.8	5.1
- Kerosene for lighting	litre	NA	NA	NA	4.3
- Kerosene for cooking(c)	litre	NA	NA	NA	0.8
- LPG	kg	-	-	-	0.01
- Electricity	kWh	0.5	0.3	2.2	4.9
B. Non-Commercial Fuels					
- Fuelwood	kg	234.7	270.1	251.9	40.1
- Charcoal	kg	0.6	0.7	0.1	0.2
- Dungcakes	kg	126.8	100.8	72.7	133.1
- Other Solid fuels(d)	kg	72.3	9.8	12.4	176.9

a) As quoted in Ashok V. Desai, Inter-fuel Substitution in the Indian Economy, Discussion Paper D-73B, Resources for The Future, Washington, D.C.; 1981.

b) NCAER (1981), op cit Ref. Table III.5.1.

c) Also includes water heating and space heating.

d) Includes crop wastes, sawdust, woodshavings, twigs, leaves etc.

Note: "Fuelwood" and "Other solid fuels" may be clubbed together in order to facilitate a comparison of estimates of per-capita non-commercial energy consumption across the years.

Table III.5.3 : Estimates of Annual Per-Capita Energy Consumption in Urban Areas

	Units	1963/64[a]	1973/74[a]	1978/79[b]
A. Commercial Fuels				
- Coal/Soft-coke	kg	29.8	33.4	31.3
- Kerosene (total)	litre	10.2	14.0	11.6
- Kerosene for lighting[c]	litre	NA	NA	2.6
- Kerosene for cooking	litre	NA	NA	9.0
- LPG	kg	-	-	2.2
- Electricity	kWh	9.0	18.2	35.0
B. Non-Commercial Fuels				
- Fuelwood	kg	169.3	148.6	82.8
- Charcoal	kg	4.4	2.6	3.8
- Dung cakes	kg	33.3	25.2	35.7
- Other solid fuels[d]	kg	3.5	4.9	41.5

a), b), c), d) : Refer to Table III.5.2.

Note : "Fuelwood" and "Other solid fuels" may be clubbed together in order to facilitate a comparison of estimates of per-capita non-commercial energy across the years.

Table III.5.4: Estimates of Annual Per-Capita Energy Consumption in Metropolitan Cities

	Units	Delhi (1958)	Calcutta (1958)[a]	Bombay (1958)[a]	Bombay (1972)[b]	Delhi (1978/79)
A. Commercial Fuels						
- Coal/Soft-coke	kg	54.6	84.0	26.7	3.0	67.7
- Kerosene (total)	litre	8.9	8.6	31.1	34.3	19.0
- Kerosene for lighting	litre	2.5	4.5	2.9	NA	0.2
- Kerosene for cooking(c)	litre	6.4	4.1	28.2	NA	18.8
- LPG	kg	-	-	-	8.8(d)	5.7
- Electricity(total)	kWh	52.3	53.7	37.9	108.5	90.6
- Electricity for lights & fans	kWh	29.0	41.3	29.5	NA	61.0(e)
- Electricity for other uses	kWh	23.3	12.4	8.4	NA	29.6
B. Non-Commercial Fuels						
- Fuelwood	kg	18.7	28.8	28.7	9.7	6.7
- Charcoal	kg	10.9	2.4	72.7	6.0	-
- Dungcakes	kg	14.4	6.7	0.6	(f)	1.9
- Other solid fuels(g)	kg	NA	8.9	0.8	7.0	12.3

a) Survey done during summer months.
b) Survey done in an unspecified month.
c) Also includes water heating and space heating.
d) In cubic metres.
e) For lighting only.
f) Included in other solid fuels.
g) Comprises crop-wastes, straw, twigs, leaves etc.

Source: For Delhi (1978/79): NCAER(1981), op cit Ref. Table III.5.1.
For others: As quoted in Ashok V. Desai (1981), op cit Ref. Table III.5.2.

Table III.5.5: Total Annual Commercial Energy Consumption -- A Comparison of Survey Estimates and Official Estimates

	Units	1963/64	1973/74	1978/79
Survey Estimates				
- Soft-coke	'000 tonnes	2081	3285	5483
- Kerosene	'000 tonnes	2381	4674	3376
- Electricity	GWh	883	3147	7317
Official Estimates(a)				
- Soft-coke	'000 tonnes	2279	2911	2680
- Kerosene	'000 tonnes	2437	3451	3312
- Electricity	Gwh	2062	4645	7577

a) Based on production and sales data.

Source: For 1963/64 and 1973/74: As quoted in Ashok V. Desai (1981); op cit Ref. Table III.5.2. For 1978/79: Survey Estimates--NCAER (1981); op cit Ref. Table III.5.1; Official Estimates from : (i) Dept. of Petroleum, Indian Petroleum and Petrochemical Statistics, GOI, New Delhi. (ii) CEA, Public Electricity Supply: All India Statistics--General Review, New Delhi. (iii) Coal Controller's Organization, All India Annual Coal Statistics, Calcutta.

Table III.5.6: Commercial and Non-Commercial Energy Consumption in Rural and Urban Areas in 1978/79

Annual Household Income Category (Rs.)	Rural			Urban		
	Total (mtcr)	Commer. (%)	Non-Com. (%)	Total (mtcr)	Commer. (%)	Non-Com. (%)
0 - 3000	45.8	9.2	90.8	8.3	33.9	66.1
3001 - 6000	32.0	11.0	89.0	14.7	55.0	45.0
6001 - 12000	14.2	13.7	86.3	10.4	69.9	30.1
12001 - 18000	2.3	14.4	85.6	17.8	77.1	22.9
> 18000	1.8	17.1	82.9	1.8	84.7	15.3
All Classes	96.0	10.7	89.3	36.9	56.9	43.1

(1) mtcr: million tonnes of coal replacement.

(2) The following conversion factors are used to convert fuel consumption from physical units to 'mtcr' units:

Soft-coke/Coal : 1 MMT = 1.5 mtcr.
Kerosene (for lighting): 1 million kilolitres = 2.086 mtcr.
Kerosene (for cooking) : 1 million kilolitres = 5.623 mtcr.
LPG: 1MMT = 10.184 mtcr.
Electricity: 1000 GWh = 0.706 mtcr.
Firewood: 1MMT = 0.655 mtcr.
Charcoal: 1MMT = 1.807 mtcr.
Dungcakes: 1MMT = 0.301 mtcr.
Crop Residues: 1MMT = 0.527 mtcr.

Source: NCAER (1981), op cit Ref. Table III.5.1.

Table III.5.7: Use of Commercial Energy For Cooking and Lighting in Rural and Urban Areas in 1978/79

Annual Household Income Category (Rs.)	Rural		Urban	
	For Cooking[a] (%)	For Lighting[b] (%)	For Cooking[a] (%)	For Lighting[b] (%)
0 - 3000	33.7	66.3	78.3	21.7
3001 - 6000	41.3	58.7	84.6	15.4
6001 - 12000	52.7	47.3	86.5	13.5
12001 - 18000	55.2	44.8	86.0	14.0
> 18000	61.2	38.8	84.8	15.2

a) Includes water heating and space heating.

b) Includes the use of fans, refrigerators, television sets and other electrical appliances.

Note: All commercial energy consumption for the two end-uses is first expressed in 'mtcr' units. Only then is it possible to estimate the percentage of commercial energy use in the two major end-uses.

Source: NCAER (1981), op cit Ref. Table III.5.1.

Table III.5.8: Official Estimates for Commercial Energy Consumption

	Soft-Coke (MMT)	LPG (MMT)	Kerosene (MMT)	Electricity (GWh)
1972/73	3.16	NA	3.492	4309.01
1973/74	4.65	NA	3.300	4644.55
1974/75	4.02	NA	2.895	5172.79
1975/76	3.63	0.266	3.104	5821.35
1976/77	4.02	0.270	3.322	6336.56
1977/78	3.54	0.290	3.634	6821.31
1978/79	2.68	0.302	3.952	7575.66
1979/80	3.38	0.332	3.872	8402.23
1980/81	3.05	0.327	4.228	9246.43
1981/82	3.02	0.424	4.693	10439.62
1982/83	2.34	0.530	5.214	12091.63

Source : op cit Ref. Table III.5.5.

Table III.5.9: Average Efficiency of Utilization of Cooking Fuels (%)

Commercial Fuels	
- Soft-coke/Coal	10
- Kerosene (in pressure stove)	56
- Kerosene (in wick stove)	42
- LPG	63
Non-Commercial Fuels	
- Firewood (in closed hearth)	16
- Firewood (in open hearth)	13
- Twigs and Straw (in closed hearth)	16
- Twigs and Straw (in open hearth)	13
- Charcoal	16
- Dungcake	8

Source: NCAER, Energy Demand in Greater Bombay, New Delhi, 1975.

Table III.5.10: Production of Selected Household Appliances ('000)

	1970	1975	1980	1983
a. Incandescent lamps	10300	12900	20200	27300
b. Electric Fans	1570	1310	4120	4440
c. TV Sets	5.1	39.4	86.8	139.0
d. Refrigerators	65.4	108.9	278.6	450.0
e. Portable Room Air-Conditioners	17.0	19.0	26.2	28.0

Source: Centre for Monitoring Indian Economy, Production and Capacity Utilization in 650 Industries (1970 to 1983), Bombay, 1984.

III.6 Commercial/Services Sector

Schools, hospitals, private businesses, hotels, restaurants, Government buildings, offices and other energy consuming centres not included in the agriculture, industry, transport and residential sectors comprise the commercial/services sector.

It is therefore clear that a wide variety of energy consuming end-use activities characterize this sector. However, it is known that this sector is not a major energy consumer.

Reliable time series data for only electricity consumption are available. Electricity consumption data, though not fully disaggregated by type of establishment or service, do provide useful information. For other fuels, it may be best to rely on information gathered through sample surveys.

Table III.6.1 : Commercial/Services Sector -- Gross Value Added (Rs. million, 1970/71 prices)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Trade, Hotels and Restaurants	40430	43130	52510	58410	69759
b. Banking and Insurance	6560	7790	10130	13000	15670
c. Real Estate, Ownership of Dwellings and Business Services	14580	15700	17110	18730	22440
d. Public Administration and Defence	16350	19800	23700	31300	43790
e. Other Services	16790	17820	19340	21300	24750
f. Total	**94710**	**104240**	**122790**	**142740**	**176409**

Source : Central Statistical Organisation, National Accounts Statistics, GOI, New Delhi, Various Issues.

Table III.6.2 : Electricity Consumption in Commercial/Services Sector (GWh)

	1970/71	1973/74	1976/77	1979/80	1982/83
a. Commercial Establishments	2572.66	2987.52	4141.92	4656.58	5846.25
b. Public Lighting	492.66	552.83	594.24	711.62	835.79
c. Public Water Works and Sewage Pumping	1016.51	1116.96	1444.13	1407.76	1757.36
d. Miscellaneous	381.67	622.15	697.74	1196.80	1640.74
e. Total	**4463.50**	**5279.46**	**6878.03**	**7972.76**	**10080.14**

Source : CEA, op cit Ref. Table III.5.5.

Table III.6.3 : Estimated Fuel Consumption in Commercial/Services Establishments in Rural Areas (1978/79)

	Units	Livestock Forestry & Allied Activities	Manufacturing Servicing, Processing & Repair	Trade and Commerce	Communication	Other	Total
Coal/Coke	'000tonnes	-	4492.3	133.8	0.3	56.7	4683.1
HSD	'000 kl	-	67.0	-	-	-	67.0
Furnace Oil	'000 kl	-	4.7	-	-	-	4.7
Kerosene	'000 kl	88.6	97.7	248.2(a)	3.4	154.2	592.1
Electricity	GWh	-	1517.8	481.1	7.2	386.7	2392.8
Firewood	'000 tonnes	-	1685.6	625.6	-	374.3	2685.5
Charcoal	'000 tonnes	-	371.2	9.5	-	77.6	458.3
Veg.Wastes	'000 tonnes	-	229.0	75.8	-	-	304.8

a) Includes 96,200 kl used for heating/cooking in hotels and restaurants

Source : NCAER (1981), op cit Ref. Table III.5.1.

Table III.6.4 : Estimated Fuel Consumption in Commercial/Service Establishments in Urban Areas (1978/79)

	Units	Hotels and Restaurants	Hospitals	Laundries	Others	Total
Coal/Coke	'000 tonnes	644.9	22.1	49.7	-	716.7
LPG	'000 tonnes	60.23	2.55	-	-	62.78
Kerosene	'000 kl	164.0	21.3	14.9	13.3	213.5
Electricity	GWh	406.8	213.2	149.7	-	769.7
Town gas	'000 m^3	19.4	2.9	-	-	22.3
Firewood	'000 tonnes	805.8	27.6	106.1	-	939.5
Charcoal	'000 tonnes	176.6	6.9	51.5	-	235.0
Crop Wates	'000 tonnes	166.4	-	-	-	166.4

Source : NCAER (1981), op cit Ref. Table III.5.1.

IV. ENERGY COSTS AND PRICES

To the energy planner, a knowledge of true economic costs incurred in the supply of an energy carrier is most essential. This includes both the average cost associated in maintaining the present level of supply, and the marginal cost associated with increasing supply. However, economic cost data are not usually documented; at most, financial cost data for a particular project are available.

On the other hand, price data (per unit of an energy carrier) are readily available, and are presented in five tables in this section. These administered energy prices usually do not reflect the economic costs, because in setting the prices, the Government takes into consideration several non-economic objectives. The differences between c.i.f. import and retail prices of certain petroleum products highlights this issue.

Furthermore, it is important to note that even the price data presented here is by no means complete. Data for only the pit-head price of coal (averaged over all grades of coal) are presented. This of course, does not provide a complete picture regarding the price paid by a particular consumer at a specific location and for a specific grade of coal. Likewise, only average electricity tariffs (averaged over all categories of consumers) are presented. Similarly, the build-up of petroleum product prices is also not given.

Table IV.1.1 : Average Pithead Price of Coal (Rs/tonne)

1960	20.75
1965	23.73
1970	35.63
1972	36.41
1974	51.46
1976	70.14
1978	70.37
1980	118.95
1982	150.3
1984	187.5

Source: Centre for Monitoring Indian Economy, Basic Statistics Relating to the Indian Economy, Vol.I, All India; Bombay, August 1984.

Table IV.2.1 : Prices of Indigenous Onshore and Offshore Crude Oils* (Rs/tonne)

	With Effect From					
	July 14, 1975	Sept.8, 1976	Dec.16, 1977	April 1, 1981	July 11, 1981	Feb.15, 1983
A. Onshore Crude Oils						
Base Price	195.04	230.41	203.41	203.41	1021	1021
Cess	60	60	60	60	100	300
Royalty	15	15	42	61	61	61
Total	270.04	305.41	305.41	324.41	1182**	1382**
B. Offshore Crude Oils						
Base Price			331.65	331.65	1021	1021
Cess			60	60	100	300
Royalty			42	61	61	61
Total			433.65	452.65	1182**	1382**

* The prices presented here are for crude oils of 34° API gravity. They are subject to an escalation of Rs.0.16/°API, upto a maximum of 45°API. No downward limit on the °API gravity for a de-escalation in prices is specified. The prices are also inclusive of sales-tax, which is the liability of the producer.

Source : Department of Petroleum, Annual Petroleum and Petrochemical Statistics, GOI, New Delhi, various issues.

Table IV.2.2 : Retail Selling Prices of Selected Petroleum Products (in Bombay)

Prices as on	Mogas/ Petrol* (Rs/litre)	HSD (Rs/litre)	Kerosene (Rs/litre)	LPG** (Rs/Cylinder)
Jan 1, 1971	1.16	0.79	0.54	NA
Jan 1, 1972	1.42	0.83	0.57	NA
Jan 1, 1973	1.43	0.83	0.61	NA
Jan 1, 1974	2.82	0.81	0.82	20.01
Jan 1, 1975	3.26	1.06	1.04	22.10
Jan 1, 1976	3.36	1.28	1.21	26.75
Jan 1, 1977	3.39	1.27	1.21	26.75
Jan 1, 1978	3.38	1.27	1.18	26.75
Apr 1, 1979	4.04	1.39	1.29	26.94
Aug 17, 1979	4.87	1.58	1.46	33.96
Nov 11, 1979	5.15	1.50	1.39	33.96
Jun 8, 1980	5.15	2.21	1.39	33.96
Jan 13, 1981	5.56	2.61	1.49	38.94
July 11, 1981	6.15	2.96	1.60	43.52
Apr 1, 1982	6.15	2.96	1.66	43.52
Feb 15, 1983	6.21	3.21	1.70	43.14
Apr 1, 1983	6.21	3.21	1.80	43.14
Apr 1, 1984	6.32	3.21	1.81	43.14
Jun 1, 1984	6.41	3.27	1.85	44.11
Apr 1, 1985	7.34	3.45	2.03	49.95

* Price for Mogas 83 until April 1, 1983; Price for Mogas 87 thereafter.

** Price for a 15 kg cylinder until Jan 1, 1975; Price for a 14.2 kg cylinder thereafter.

Source : Department of Petroleum, op cit Ref. Table IV.2.1.

Table IV.2.3 : c.i.f. Price of Crude and Selected Petroleum Products (in Bombay)*

		Crude Oil (Rs/tonne)	Mogas[a)] (Rs/litre)	Gas Oil[b)] (Rs/litre)	Kerosene[c)] (Rs/litre)
1980	(mid-Feb)	1815.90	2.02	1.91	1.96
	(mid-Aug)	1801.82	2.15	2.10	2.20
	(mid-Nov)	1846.93	2.13	2.13	2.23
1981	(mid-Feb)	2210.85	2.39	2.39	2.54
	(mid-Aug)	2270.42	2.60	2.60	2.73
	(mid-Nov)	2349.79	2.68	2.68	2.82
1982	(mid-Feb)	2275.19	2.61	2.71	2.85
	(mid-Aug)	2340.22	2.65	2.71	2.85
	(mid-Nov)	2378.73	2.71	2.78	2.92
1983	(mid-Feb)	2241.08	2.74	2.81	2.96

a) 1 tonne of mogas = 8.6 barrels = 1367 litres.
b) 1 tonne of gas oil = 7.4 barrels = 1176 litres.
c) 1 tonne of kerosene = 7.9 barrels = 1256 litres.

* Exchange rate increased gradually from Rs. 7.9582 = 1 US$ in Feb.1980 to Rs. 9.933 = 1 US$ in Feb. 1983.

Source : World Bank.

Table IV.3.1 : Electricity Tariffs (All India Average) (p/kWh)

1970/71	12.44
1972/73	14.15
1974/75	18.39
1976/77	23.79
1978/79	28.99
1979/80	31.28
1980/81	33.23
1981/82	38.76
1982/83	43.45
1983/84	51.55

Source : Centre for Monitoring Indian Economy (1984), op cit, Ref. Table IV.1.1.

V. TECHNOLOGY DEVELOPMENT

The supply and demand scenario for the so-called "conventional" energy forms is presented in the preceeding sections. However, with technological development, it becomes possible to: (i) harness certain renewable energy sources, such as solar and wind, as also hydroelectric potential from low heads; and (ii) improve the utilization efficiency of certain fuels that are already used, such as biomass.

None of these "non-conventional" technologies are today economically or commercially viable, and the Government has therefore established a R&D programme to improve them and/or to reduce their costs. In addition, a sizeable demonstration and field testing programme has also been launched for certain technologies, to familiarize the potential users, as well as to gather performance data under field conditions. For technologies where the demonstration and/or extension programme has already gathered sufficient momentum (such as solar thermal, solar electric wind-pumping, biogas, and improved chulhas), the feedback obtained so far has provided some guidelines for improving the designs to suit a particular application. Relevant data are presented for such technologies as well as for wind electricity generation -- field testing for which is anticipated to increase substantially within the next year or so.

As it is quite clear that the potential for non-conventional energy technologies is location and end-use specific, sample data for solar insolation and wind speeds are also presented. Likewise, relevant data on biomass potential/supply are presented in section II.4.

In tables V.1.1 through V.4.2, wherever the source is not listed, the data are obtained from the Annual Report 1985/86 of the Department of Non-Conventional Energy Sources (DNES), Government of India.

Table V.1.1 : New Delhi -- Mean Daily Global Solar Radiation (GSR)*

	Mean GSR (KWh/sq.m/day)	Clear Sky GSR at noon (KWh/sq.m)	Ratio of Mean Daily GSR on Overcast Days to Clear Days
January	3.99	0.666	0.33
February	5.00	0.774	0.26
March	6.14	0.884	0.32
April	6.93	0.941	0.31
May	7.29	0.950	-
June	6.47	0.929	0.33
July	5.33	-	-
August	5.05	0.889	0.27
September	5.60	0.852	0.25
October	5.35	0.773	0.32
November	4.52	0.701	0.25
December	3.84	0.642	0.34

* The type of data presented in tables V.1.1 through V.1.3 are available for 16 locations having major meteorological observatories: Ahmedabad, Bhavnagar, Bombay, Calcutta, Goa, Jodhpur, Kodaikanal, Madras, Mangalore, Nagpur, New Delhi, Port Blair, Pune, Shillong, Trivandrum and Vishakhapatnam. In addition, some meteorological data are also available for 129 stations, which cover all major climatic zones of the country.

Source : A.Mani and S.Rangarajan, Solar Radiation Over India, Allied Publishers Pvt.(Ltd.), 1982.

Table V.1.2 : New Delhi -- Median Values of Hourly And Daily Global Solar Radiation* (kWh/sq.m.)

	Local Apparent Time** Ending At (Hours)													
Month	6	7	8	9	10	11	12	13	14	15	16	17	18	Daily Total
Jan	.00	.00	.00	.28	.45	.57	.66	.65	.57	.44	.28	.00	.00	4.15
Feb	.00	.00	.17	.38	.56	.69	.77	.77	.69	.56	.38	.17	.00	5.19
Mar	.00	.00	.28	.48	.68	.81	.88	.88	.80	.66	.47	.26	.00	6.34
Apr	.00	.15	.34	.56	.76	.88	.93	.93	.87	.72	.55	.32	.13	7.13
May	.00	.18	.40	.59	.78	.90	.94	.93	.88	.76	.56	.38	.17	7.51
Jun	.00	.17	.35	.54	.70	.80	.87	.86	.79	.67	.52	.33	.17	6.76
Jul	.00	.13	.28	.47	.61	.71	.74	.75	.68	.58	.45	.29	.15	5.66
Aug	.00	.00	.26	.42	.57	.68	.71	.73	.66	.56	.43	.27	.00	5.45
Sep	.00	.00	.27	.46	.65	.77	.81	.80	.76	.64	.44	.27	.00	6.07
Oct	.00	.00	.19	.42	.59	.71	.79	.79	.70	.57	.41	.19	.00	5.50
Nov	.00	.00	.14	.32	.52	.65	.69	.68	.64	.51	.31	.13	.00	4.60
Dec	.00	.00	.00	.28	.43	.55	.65	.64	.55	.42	.28	.00	.00	4.02

* Based on Data from 1957 to 1978.

** Local Apparent time minus Indian Standard Time for specified dates:

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-24.1	-34.8	-33.7	-25.2	-18.3	-18.8	-24.8	-27.5	-21.3	-11.0	-4.8	-10.1
11	-29.0	-35.5	-31.4	-22.4	-17.5	-20.6	-26.5	-26.4	-18.0	-8.1	-5.2	-14.2
21	-32.4	-34.9	-28.6	-20.0	-17.7	-22.7	-27.5	-24.4	-14.4	-5.9	-7.0	-19.1

Source: Mani and Rangarajan (1982), op cit Ref. Table V.1.1.

Table V.1.3 : New Delhi — Percentage Frequency and Cumulative Percentage Frequency Distribution of Daily Global Solar Radiation*

Class Interval (kWh/ sq.m.)	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF	% F	% CF
.00- .50																								
.50- 1.00	1	1											1	1	1	1								
1.00- 1.50	1	2	1	1									1	2	2	3	1	1			1	1	1	1
1.50- 2.00	1	3	1	2									3	5	4	7	2	3	1	1		1	1	2
2.00- 2.50	2	5	1	3	1	1	1	1					3	8	5	12	2	5		1		1	3	5
2.50- 3.00	5	10	2	5	1	2		1			1	1	5	13	7	19	3	8	1	2	1	2	3	8
3.00- 3.50	10	20	2	7	1	3	1	2	1	1	1	2	5	18	5	24	1	9	1	3	2	4	12	20
3.50- 4.00	20	40	7	14	1	4		2		1	2	4	5	23	6	30	5	14	2	5	9	13	28	48
4.00- 4.50	33	73	7	21	2	6	1	3	1	2	3	7	8	31	7	37	4	18	3	8	29	42	46	94
4.50- 5.00	24	97	18	39	3	9	1	4	1	3	3	10	8	39	8	45	7	25	11	19	40	82	6	100
5.00- 5.50	3	100	29	68	9	18	3	7	2	5	6	16	9	48	6	51	7	32	31	50	17	99		
5.50- 6.00			21	89	13	31	5	12	3	8	9	25	10	58	9	60	14	46	37	87	1	100		
6.00- 6.50			10	99	29	60	10	22	8	16	16	41	10	68	11	71	30	76	13	100				
6.50- 7.00			1	100	27	87	19	41	13	29	18	59	12	80	14	85	20	96						
7.00- 7.50					12	99	35	76	21	50	18	77	12	92	10	95	4	100						
7.50- 8.00					1	100	20	96	28	78	18	95	6	98	3	98								
8.00- 8.50							4	100	19	97	5	100	2	100	1	99								
8.50- 9.00									3	100					1	100								
9.00- 9.50																								
9.50-10.00																								

* Based on Data from 1957 to 1978.

Source : Mani and Rangarajan (1982), op cit Ref. Table V.1.1.

Table V.1.4 : Solar Thermal Devices -- Statement of Achievement of the Demonstration/Extension Programme (As on January 15, 1986)

	Solar Water Heating Systems*			
	No. of Installations	Capacity (litres/ day)	Collector Area (sq.m.)	Number of other Solar Thermal Systems Installed
Andhra Pradesh	10	65000	1254	3
Assam	8	2000	40	4
Arunachal Pradesh	-	-	-	1
Bihar	1	4000	80	-
Delhi	54	210650	4174	14
Gujarat	102	213309	4033	89
Haryana	11	48600	985	1
Himachal Pradesh	3	3000	70	-
Karnataka	10	14050	324	2
Kerala	-	-	-	1
Madhya Pradesh	98	280694	6474	5
Maharashtra	11	37000	822	-
Orissa	6	12700	224	4
Punjab	11	47000	935	4
Rajasthan	36	20000	420	-
Tamil Nadu	8	133000	2900	2
Uttar Pradesh	91	70500	1412	31
West Bengal	-	-	-	1
All States	460	1171303	24147	162

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* Excludes Domestic Solar Water Heaters.

Table V.1.5 : Solar Thermal Devices -- Number of Installations (As on January 15, 1986)

	No. of Units Installed Until March 31, 1985	No. of Units Installed from April 1, 1985 to Jan. 15, 1986	Total No. of Units Installed Until Jan. 15, 1986*
a. Solar Water Heating Systems	182	272	460
b. Solar crop dryers/air heating systems	12	11	23
c. Solar timber kilns	12	8	20
d. Solar desalination systems	28	91	119
e. Domestic solar water heaters	200	100	300
f. Total	434	488	922

* In addition, about 46000 solar cookers have also been installed.

Table V.1.6 : Solar Photovoltaic -- No. of Systems Supplied by Indigenous Manufacturers (during April 1, 1985 to Jan. 31, 1986)

	CEL	BHEL
a. Water Pumping Systems	69	35
b. TV and TV-cum-lighting Systems	212	1
c. Community Lighting Systems	7	-
d. Street Lighting Units	637	338
e. Systems for off-shore oil platforms	-	6
f. Modules for battery charging units	300	300
g. Other Systems	27	1

Table V.1.7 : Photovoltaic Systems -- Status of the Demonstration Programme

	Application	Status/Achievements
(i)	Pumping	As recommended by the Advisory Board on Energy, 100 pumps were installed in Six States (Andhra Pradesh, Bihar, Orissa, Tamil Nadu, Uttar Pradesh, and West Bengal), until Dec. 1985. In addition, 46 systems were also supplied to various states for the purpose of demonstration. A programme for setting up another 300 demonstration units is being implemented.
(ii)	Community TV sets	200 PV powered TV sets are being installed in Uttar Pradesh and Bihar.
(iii)	Village Electrification	Programme to have PV powered street lights in 250 villages was initiated in 1984/85. About 160 villages were completed until December 1985; and supplies for another 25 villages had been made.
(iv)	Centralized PV Systems	In 4 of the above villages, "centralized" PV powered systems for meeting street lighting and other electrical energy requirements are being set up. Moreover, DNES has also proposed to set up 4 PV power stations, each in the capacity range of 10-20 kW.

Table V.2.1 : Stations with Annual Mean Windspeed >= 13 Km/hour

No.	Station	Wind Speed (km/hour)	Period of measurement
1.	Alibag	14.1	1958-67
2.	Amini Divi	14.1	1963-69
3.	Bhavnagar	18.0	1958-67
4.	Bhuj	13.3	"
5.	Bidar	13.3	"
6.	Coimbatore airport	18.1	"
7.	Dhanu	14.9	"
8.	Devgarh	16.6	"
9.	Dohad	14.6	"
10.	Dwaraka	17.3	"
11.	Gopalpur	14.5	"
12.	Harnai	15.4	"
13.	Indore	14.4	"
14.	Jaisalmer	13.0	"
15.	Jalgaon	13.5	"
16.	Kandla airport	20.7	1961-69
17.	Kanniyakumari	17.7	1961-67
18.	Keshod airport	17.5	1958-67
19.	Kodaikanal	13.2	"
20.	Mahabaleshwar	13.1	"
21.	Mandvi	22.8	"
22.	Nagapattinam	13.9	"
23.	Naliya	13.5	"
24.	Okha	20.6	1963-69
25.	Pamban	14.5	1958-67
26.	Phalodi	13.3	"
27.	Porbandar	15.5	"
28.	Puri	16.3	1960-69
29.	Rajkot	18.6	1958-67
30.	Sagar Island	19.6	"
31.	Tiruchchirappalli	13.7	"
32.	Tondi	15.4	"
33.	Tuticorin	16.8	"
34.	Veraval	19.5	"

Source : Anna Mani and D.A. Mooley, Wind Energy Data for India, Allied Publications, 1983.

Table V.2.2 : Diurnal Variation of Surface Wind Speed*
(range of speed x 100/mean speed)

No.	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1.	Ahmadabad	81	86	84	63	57	67	47	31	55	106	137	114	56
2.	Amritsar	61	53	64	66	52	57	59	69	73	79	98	84	45
3.	Bangalore	66	81	108	73	40	38	37	34	47	62	116	66	51
4.	Bangalore	44	63	94	65	48	44	47	47	55	63	52	53	47
5.	Baroda	48	53	90	105	85	85	79	62	80	87	36	47	60
6.	Bhopal	55	55	81	86	67	60	49	48	77	107	104	66	53
7.	Bombay - Colaba	99	97	120	129	100	21	15	16	51	99	75	91	58
8.	Bombay - Santacruz	135	134	148	166	148	82	29	41	103	135	96	110	89
9.	Calcutta - Alipore	104	92	73	63	72	67	72	78	90	114	111	133	77
10.	Calcutta - Dum Dum	158	113	81	71	79	76	75	92	87	144	147	166	86
11.	Gaya	157	159	177	136	113	99	80	74	74	117	185	209	114
12.	Goa	86	110	117	122	93	26	17	28	88	132	84	66	63
13.	Gopalpur	102	102	80	43	52	64	77	92	93	79	90	94	66
14.	Hyderabad	85	92	92	71	83	60	60	72	83	129	104	119	67
15.	Indore	58	83	60	48	48	48	42	40	46	75	65	47	39
16.	Jagdalpur	245	223	184	131	139	118	125	129	159	215	200	259	154
17.	Jaipur	72	81	108	127	96	105	115	134	132	143	117	87	95
18.	Jamnagar	116	111	123	125	106	88	74	82	100	127	132	110	97
19.	Jamshedpur	245	206	161	128	161	124	127	117	109	196	269	360	135
20.	Jharsuguda	96	97	96	109	73	82	69	70	119	112	119	140	75
21.	Kandla	28	41	57	82	72	59	48	56	78	42	41	27	[illegible]
22.	Kodaikanal	69	82	70	48	29	18	24	24	30	33	38	49	38
23.	Lucknow	80	90	108	130	101	81	75	83	91	149	123	96	93
24.	Madras Harbour	48	71	85	74	49	51	53	45	48	56	44	37	52
25.	Madras - Minambakam	156	177	167	132	69	68	77	79	77	120	123	128	93
26.	Mangalore	178	209	234	210	161	85	63	101	170	188	171	159	153
27.	Nagpur	58	60	60	65	91	67	87	82	85	92	88	72	60
28.	New Delhi - Palam	107	99	104	116	85	62	54	70	83	106	132	130	84
29.	New Delhi - Safdarjung	120	115	112	114	90	85	87	105	114	173	185	149	104
30.	Port Blair	94	125	190	197	100	77	82	68	99	127	66	46	86
31.	Pune	239	211	221	193	107	78	74	70	119	200	284	315	122
32.	Raipur	178	159	131	110	102	76	81	78	110	174	210	227	111
33.	Sagar Island	129	67	32	27	28	28	25	25	31	72	123	128	31
34.	Tiruchchirappalli	84	121	149	145	55	43	40	43	66	77	82	74	52
35.	Tuticorin	36	48	61	92	89	66	55	59	78	69	31	19	57
36.	Veraval	67	82	77	76	47	14	6	18	40	89	102	65	38
37.	Vishakhapatnam	247	261	228	146	148	111	104	131	164	174	151	211	162

* Only for stations which have a pressure tube anemograph for continuous recording of wind speed and wind direction. At over 300 other stations, with a cup-anemometer, or those taking upper wind observations, the recording is not continuous.

Source : Mani and Mooley, op cit Ref. Table V.2.1.

Table V.2.3 : Windpumps -- Statement of Achievement of the Demonstration Programme (As on February 28, 1986)

	No. of Windmills Installed
Andhra Pradesh	162
Andaman & Nicobar Islands	14
Bihar	74
Chandigarh	4
Delhi	27
Goa	6
Gujarat	94
Haryana	30
Himachal Pradesh	9
Jammu & Kashmir	2
Karnataka	17
Kerala	4
Madhya Pradesh	164
Maharashtra	111
Nagaland	4
Orissa	144
Pondicherry	10
Punjab	77
Rajasthan	76
Tamil Nadu	83
Uttar Pradesh	198
West Bengal	11
Tripura	2
Total	1323

Table V.2.4 : Indigenously Designed Windpumping Systems

a. Whose Performance is partly Studied*

	Manufacturer	Design Name	Salient Design Features
a.1	IERT	Apolly 12-PU-500	Multivane, with 15 cm. diametre pump with an air chamber.
a.2	BHEL	-	Multivane, with 10 cm diametre brass - liner pump.
a.3	NAL	MP-2	Trapezoidal sail rotor with spoiler regulation and with 1 hp turbine pump.
a.4	NAL	MP-3	3 bladed with spoiler regulation and with 2 hp centrifugal pump.

b. Under Field Testing

	Manufacturer	Salient Design Features
b.1	Indoxy	Vertical axis windmill 'S' type rotor, diaphragm pump.
b.2	Pooja	Horizontal axis windmill, APOLLY Design.
b.3	Surya Shakti	Horizontal axis windmill, 1.5 metre plastic rotor, 6 metre tower, special piston pump.
b.4	BHEL	Horizontal axis windmill, multivane, 10 cm diametre brass liner pump.
b.5	BHEL	Horizontal axis windmill, modified and strengthened for cyclone prone areas.
b.6	BHEL	Horizontal axis windmill with provision for manual operation during non-windy periods.

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* With 10 minute test runs.

Table V.2.5 : Windfarm Demonstration Projects*

	Location	Aggregate Capacity(kW)	Unit Size(kW)	Manufacturer
a.	Mandvi (Gujarat)	1159	2x110	Micon
			+ 14x55	Micon
			+ 6x22	Windane
			+ 2x18.5	Windane
b.	Tuticorin (Tamil Nadu)	550	10x55	Windmatic
c.	Okha (Gujarat)	550	10x55	Vestas
d.	Puri (Orissa)	550	10x55	Vestas
e.	Devgarh (Maharashtra)	550	10x55	Vestas

* All were installed during 1986.

Table V.3.1 : Progress of the National Project on Biogas Development (NPBD) Progress in 1985/86*

	No. of Family Size Biogas Plants	
	Target for 1985/86	No. installed Until Dec.1985
Andhra Pradesh	20000	6811
Assam	1000	39
Bihar	6400	1215
Gujarat	4800	4468
Haryana	2200	1560
Jammu & Kashmir	120	6
Karnataka	7000	3571
Kerala	2400	1145
Maharashtra	35100	19753
Madhya Pradesh	3000	878
Orissa	2500	1989
Punjab	1600	802
Rajasthan	5000	3202
Tamil Nadu	13000	11900
Uttar Pradesh	20000	11249
West Bengal	2800	599
Himachal Pradesh	2500	2293
Pondicherry	100	27
Goa, Daman & Diu	100	24
Delhi	100	4
Dadra & Nagar Haveli	7	7
Other Union Territories**	273	-
KVIC	20000	6970
Total	150000	78512

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* Over 355,000 family sized biogas plants were installed during the period 1981/82 to 1984/85.

** Includes Tripura, Manipur, Meghalaya, Andaman & Nicobar, Chandigarh, Mizoram, Sikkim, Lakshadweep and Arunachal Pradesh.

Table V.3.2 : Achievements of the Community/Institutional Biogas Plants Demonstration Programme (As of Dec. 31, 1985)

	Number of Installations				
	Total Until March 31, 1985		Total Until Dec. 31, 1985		Grand
	CBP*	IBP**	CBP	IBP	Total
Andhra Pradesh	10	5	11	5	16
Assam	-	1	-	1	1
Delhi	1	-	1	-	1
Gujarat	6	1	7	2	9
Haryana	-	3	-	3	3
Himachal Pradesh	-	1	-	1	1
Karnataka	2	-	2	-	2
Kerala	-	1	-	2	2
Madhya Pradesh	2	12	4	15	19
Maharashtra	2	6	2	7	9
Orissa	1	-	2	-	2
Pondicherry	-	1	-	1	1
Punjab	7	2	12	2	14
Rajasthan	4	10	4	13	17
Tamil Nadu	3	1	3	1	4
Uttar Pradesh	9	14	9	37	46
West Bengal	1	-	1	-	1
Total	48	53	58	90	148

* Community Biogas Plants.

** Institutional Biogas Plants.

Table V.3.3 : National Project on Biogas Development -- Pattern of Central Subsidy for Various Categories of Consumers (Rs)

Plant Capacity (cu.m.)	For North-East Region States, Sikkim, and notified Hilly Areas & Desert Districts	For Scheduled Castes, Scheduled Tribes, Small & Marginal Farmers (including landless labourers)	For all others
1	1500	1250	830
2	2940	2350	1560
3	3660	2860	1900
4	4390	3220	2140
6	5350	3920	2610
8	6460	3100	3100
10	8080	3700	3700
15	11440	5430	5430
20	15260	7300	7300
25	17640	8190	8190

Table V.3.4 : Summary of Findings of Biogas Plant Evaluation Survey Studies*

State	Sample Size		% Plants Working		% Plants with Structural Defects		% Plants with Non-Structural Defects	
	No. of Plants	% of total	NPBD**	Pre-NPBD	NPBD	Pre-NPBD	NPBD	Pre-NPBD
a. Surveyed by National Council of Applied Economic Research, New Delhi.								
- Bihar	1087	4.7	82.1	69.3	2.6	4.4	15.3	26.3
- Uttar Pradesh	2652	3.9	77.0	72.4	5.2	3.8	17.8	23.8
- Madhya Pradesh	775	5.2	64.3	64.9	4.2	3.0	31.5	32.1
- Andhra Pradesh	792	5.5	93.6	79.7	4.6	1.3	1.8	19.0
b. Surveyed by Kirloskar Consultants Limited., Pune.								
- Haryana	1425	9.4	79.4	52.6	7.6	31.9	13.0	15.5
- Punjab	825	9.6	96.6	89.3	1.7	5.6	1.7	4.9
- Himachal Pradesh	125	5.7	100.0	100.0	Nil	Nil	Nil	Nil
c. Surveyed by Operations Research Group, Baroda								
- Karnataka	710	3.7	86.1	82.9	6.6	11.4	7.3	5.7
- Maharashtra	1347	2.8	93.0	84.8	5.4	14.4	1.6	0.8
d. Surveyed by Besant Raj Consultants (P) Ltd., Madras.								
- Tamil Nadu	1340	6.6	88.1	81.1	6.5	6.7	5.4	12.2
- Kerala	400	11.4	95.7	76.7	3.3	8.1	1.0	15.2
- Orissa	405	11.2	93.9	81.5	2.2	10.8	3.9	7.7

* For biogas plants installed until 1983/84.

** NPBD programme was initiated in 1981/82.

Table V.4.1 : Improved Chulhas -- Number Installed during 1985/86*
(As of Feb.15, 1986)

Andhra Pradesh	43235
Assam	660
Bihar	16081
Gujarat	6868
Haryana	37353
Himachal Pradesh	23725
Jammu & Kashmir	5400
Kerala	3556
Karnataka	30457
Madhya Pradesh	21642
Maharashtra	7659
Orissa	16680
Pondicherry	600
Punjab	52200
Rajasthan	93880
Sikkim	1435
Tamil Nadu	68821
Uttar Pradesh	61232
West Bengal	16345
Chandigarh	3800
Dadra & Nagar Haveli	196
Delhi	3592
Goa	2103
Manipur	200
Other States/Union Territories	31129
Total	548849

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* In addition, about 812,000 improved chulhas had been constructed during the demonstration period (December 1983 to March 1985). 21 models of fixed chulhas and 17 portable models have been approved by the DNES for dissemination.

Table V.4.2 : Improved Chulhas -- Pattern of Subsidy Granted by the DNES

	Subsidy for Scheduled Castes/ Scheduled Tribes and households in hilly areas*	Subsidy for households in other areas*	Contribution by the beneficiaries
Fixed Model of Stove	Full cost of hardware (Chimney, grates etc.)	Full cost of hardware (Chimney, grates etc.)	Labour, mud, bricks, straw and the time needed to install the stove
Portable Model of Stove	75% of the approved cost of the model	50% of the approved cost of the model	25% or 50% of the approved cost of the model (as required)

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* In addition, the DNES also pays a supervisory fee of Rs. 5/- to a trained worker for each stove constructed/installed.